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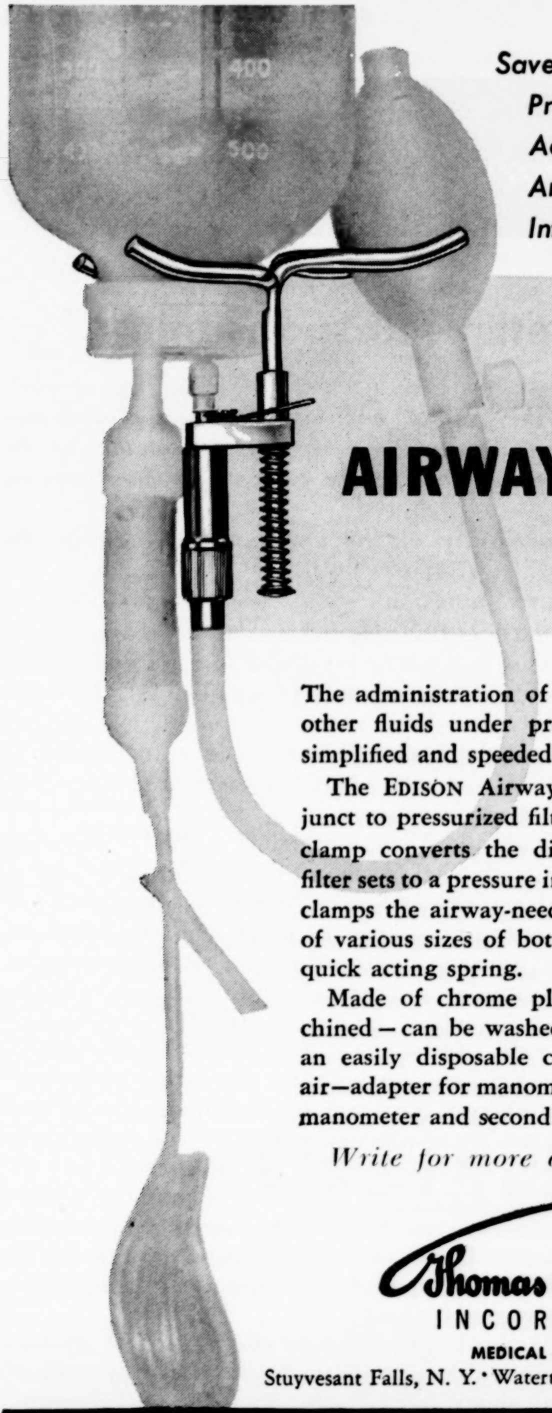

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Opinion Review

An Anesthetist's Responsibility

"The responsibility of the hospital administration and professional staff is to adopt and enforce regulations governing the conduct of the surgeon, the anesthetist and all operating room personnel in anesthetizing locations.

"It shall be the responsibility of the anesthetist to enforce the regulations."

These two sentences are quotations from the National Fire Protection Association's standard No. 56, *Recommended Safe Practice for Hospital Operating Rooms.* This particular standard is regarded almost as a Bible by electricians and contractors as well as hospital architects and others.

If we are going to be held responsible for the enforcement of certain regulations, we ought to know what they are, and why they came into being, and what their purpose is.

The first edition of this standard was published in 1941. Operating room fires and explosions with the death of patients and injury of personnel were just too dramatic to ignore. That forethought, preparedness, and safe planning could eliminate most of these accidents was an opinion held by a number of anesthetists, anesthesiologists, electrical engineers, safety engineers, hospital administrators, and the National Fire Protection Association; and a committee was formed to promulgate some safety rules. These have been added to and changed from time to time, and the 1952 edition includes the latest revisions.

Although the total number of fire and explosion accidents with fatalities was not appalling, almost all were directly connected with the use of flammable anesthetics. Because we, as anesthetists, are the ones who are actually dealing with these explosive flammable agents, it is our responsibility to use them safely. We are not only responsible for seeing to it that the patient is relaxed and oxygenated, but we are also responsible for his life safety, and that includes safety from death from explosion while anesthetized.

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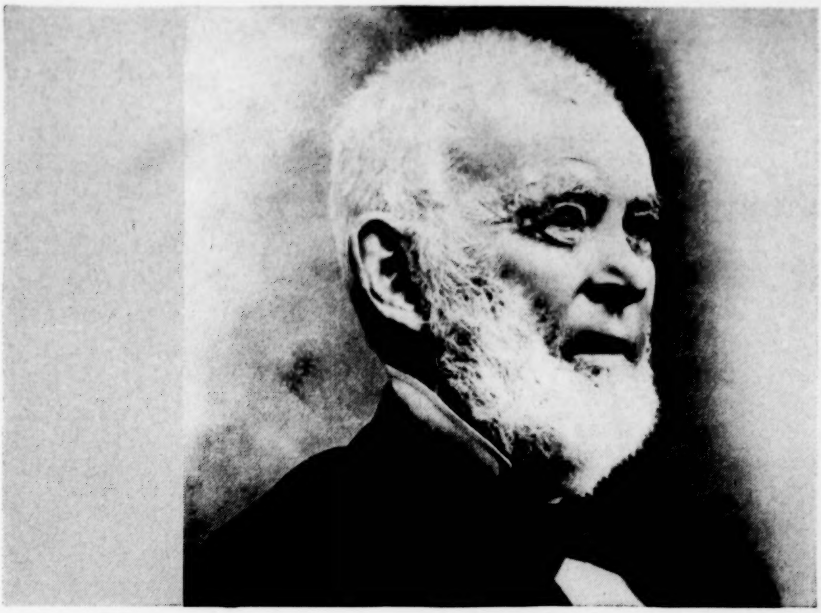
The recommendations were "formulated in the belief that reliability of materials and mechanical equipment must be utilized to the fullest extent possible in augmenting the conscious safety precautions required of operating room personnel." Precautions against anesthetic explosions should be taken anywhere flammable anesthetics are given, e.g., the surgery, delivery rooms, and emergency operating rooms. However, "*mechanical safeguards without constant human diligence are incapable of providing adequate protection.*" Any room in which an explosive anesthetic agent is being used is potentially hazardous regardless of mechanical safeguards or regulations, because of the failure of the human element in this chain of safety measures.

Static electricity plus the flammable anesthetics, as we frequently use them in closed systems with a high oxygen content, equals explosion with probable death of the patient and possible injury of personnel. It has been determined that static can be eliminated if there is perfect electrical connection of everything and each person in an operating room. The most feasible way of achieving this is to have a conductive floor, with everyone and everything connected to it by conductive contacts, plus proper humidity.

If all things in a room are electrically connected to the floor, then all have the same electric potential. If the electric potential of all things is the same, the breaking of contact between the anesthetist and patient cannot produce static spark, nor can the break of contact between the anesthetist and her stool or machine or the disconnection of mask and inhaler casting or chimney piece produce static spark. Also, if the electric potential of all things is the same, the accidental touching of the anesthesia machine by the circulating nurse or a member of the surgical team or some onlooker cannot produce static spark of sufficient intensity and heat to cause any flammable material such as ether and/or cyclopropane in a closed system to explode and in an open system to burn.

The regulations in the NFPA standard No. 56 are all based on known scientific facts or tested conditions. To know the details of your responsibilities concerning this phase of patient safety, you should own your own copy of this booklet. It may be obtained from the National Fire Protection Association, 60 Batterymarch St., Boston 10, Mass.—**Harriet L. Aberg, R.N.,** Cottage Hospital, Galesburg, Ill.



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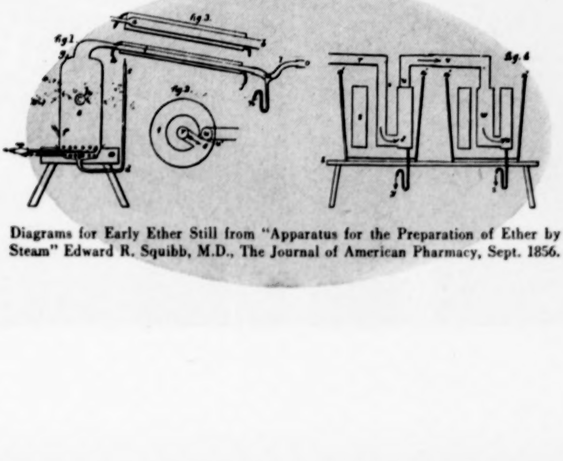

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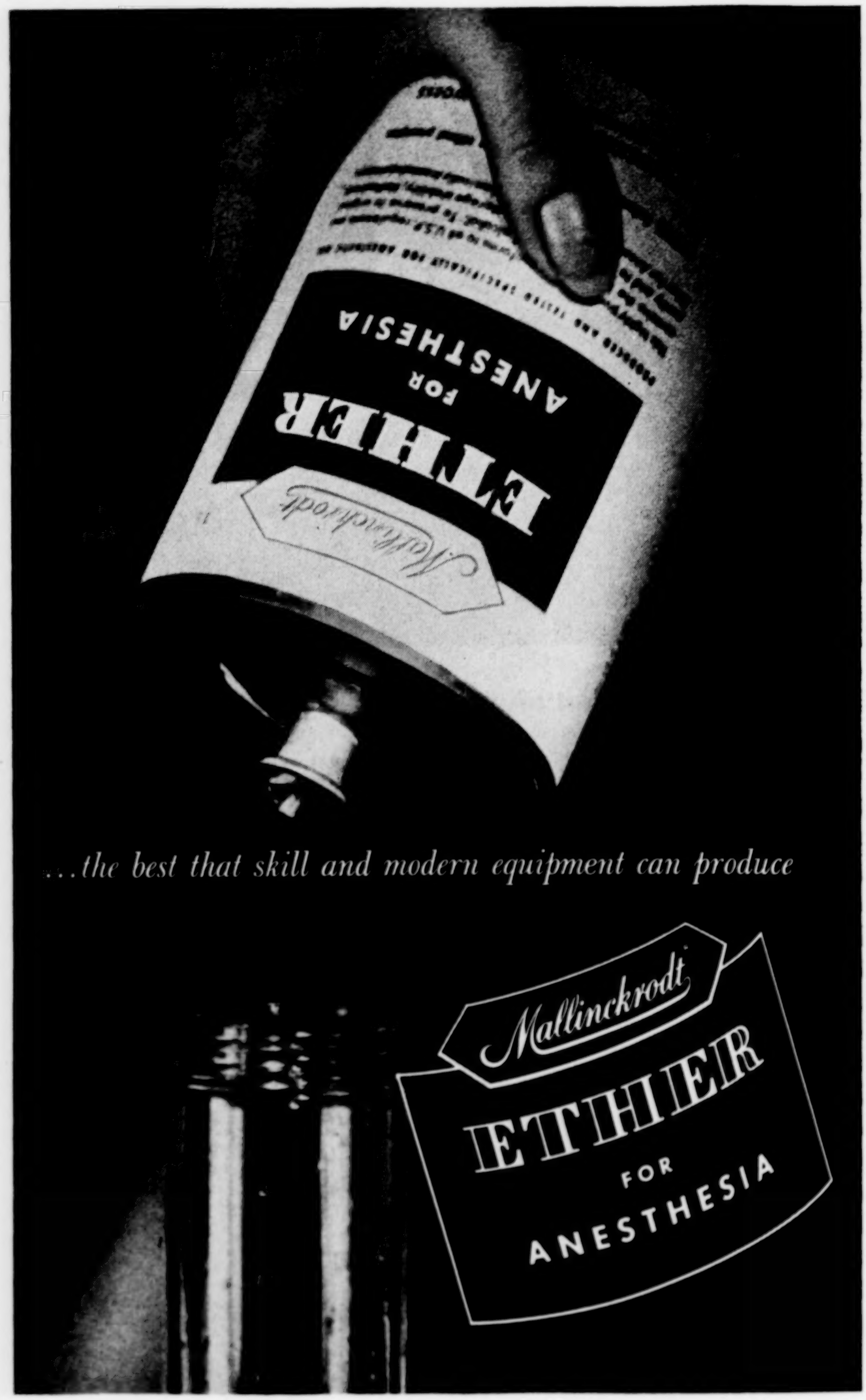
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The Journal
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Willingness to Serve

Some observers of the A.A.N.A. action in approving the statement of principles on personnel policies for nurse anesthetists drew a comparison with related actions of organized nursing and ended with being favorably impressed with nurse anesthetists. Others took out of context the statement that a forty hour week was desirable and claimed that the action was to be regretted. It might be a good idea to consider the possible results if nurse anesthetists were swayed to the extreme by either opinion.

It is true that in the statement of principles the members of the A.A.N.A. displayed the currently unfashionable professional attitude that the care and cure of sick people—and not their own professional or economic position—came first. But how sorry is the prevailing situation when being professionally right should be acclaimed as being noble?

With respect to the statement of principles regarding the forty hour week, nurse anesthetists should first thoroughly understand, and then undertake to correct any misunderstandings of, what the statement really means when it declares: "While the goal of a forty hour week is much to be desired, the shortage of nurse anesthetists makes it impracticable at the present time. Nurse anesthetists accept the fact that call duty in addition to regular duty is inherent in the service. . . ."

The number of hours nurse anesthetists spend on duty and call adds up to a total with which few if any other schedule of hours for people who take care of the sick can be compared. Nurse anesthetists know that under present conditions long hours on the job are unavoidable. But at the extreme in the acceptance of the attendant responsibilities would be a psychologic martyrdom blinding nurse anesthetists to the fact that time for rest and recreation is just as essential to them as to anyone whose productivity over many years is valuable to society.

Common Complications during Anesthesia

Mary Frances Poe, M.D., F.A.C.A.*
Memphis, Tenn.

INTRODUCTION

It is estimated that 90 per cent of the deaths occurring in patients under anesthesia are due to improper management of the airway.[1] They die indirectly from asphyxia associated with impairment of respiratory function.

Normal transport of oxygen and carbon dioxide is essential to life. A normal heart and blood vessels, normal blood, and a normal respiratory system are the body's means of transporting oxygen to the tissues and carbon dioxide to the air. Any disturbance of the mechanism controlling transport, whether due to drugs or to disease or to interference with the air or blood channels, will disrupt the vital function of the body's cells.

It is proposed to discuss some of the disturbances of the transport mechanism that frequently occur during anesthesia. These are preventable complications that can be avoided by proper attention to technical details.

ASPIRATION

Aspiration of gastric contents is a serious, often fatal accident during general anesthesia. Vomiting is only part of the problem, for silent aspiration of stomach contents by the deeply anesthetized patient is also common.

Culver et al.[2] made studies on 300 surgical patients to determine the causes and frequency of these accidents. Preoperatively, 4 cc. of a 25 per cent aqueous solution of Evans' blue dye was introduced into the stomach. As soon as the operation was over, the mouth, pharynx, larynx and trachea, and main bronchi were inspected by direct vision through laryngoscope and bronchoscope. Regurgitation (as indicated by dyed stomach contents in the pharynx) occurred in 79 of 300 patients; 24 of these showed frank vomiting; 49 patients aspirated gastric contents into the lungs. Regurgitation occurs much oftener when the patient is in the Trendelenburg or the lateral position than when he is in the horizontal, supine, or lithotomy position. Gastric tubes are protective, presum-

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Read before the Annual Meeting of the Tennessee Association of Nurse Anesthetists, Memphis, Tenn., Feb. 13, 1952.

*Assistant Professor of Anesthesiology, University of Tennessee College of Medicine; Director, Department of Anesthesiology, John Gaston Hospital.

[1] Bishop, H. F.: Operating room deaths. Anesthesiology 7:651, 1946.

[2] Culver, G. A.; Makel, H. P., and Beecher, H. K.: Frequency of aspiration of gastric contents by lungs during anesthesia and surgery. Ann. Surg. 133:289, 1951.

ably by keeping the stomach contents low in volume. When the stomach is not empty, pressure on it by the surgeon operating in the upper abdomen may possibly force gastric contents into the pharynx.

The volume of the aspirated material may produce fatal obstruction, but the irritant and infectious action of the aspirated material also may be serious. The stomach should be emptied by inducing vomiting when an emergency operation must be undertaken. Even fifteen hours after the onset of an emotional crisis or a painful injury, the stomach may still hold whatever contents it had at the beginning of that time.

Two entirely different syndromes may follow aspiration[3]: 1. Aspiration of solid food usually produces laryngeal or bronchial obstruction. Complete obstruction produces suffocation. Incomplete obstruction produces massive atelectasis with cyanosis, tachycardia, dyspnea, mediastinal shift, and signs of consolidation over the collapsed area. Obstruction should be promptly relieved, either indirectly with the aid of suction or by endoscopic removal.

2. Aspiration of liquid material produces an asthma-like syndrome. There are cyanosis, tachycardia, and dyspnea but no mediastinal shift nor massive atelectasis. Wheezes, rales, and ronchi are heard. Roentgenograms reveal irregular, soft, mottled densities without mediastinal shift. The picture has been misinterpreted as bronchopneumonia, tuberculosis, fungus infection, and even metastatic lesions. Progressive cardiac embarrassment and pulmonary edema may supervene. Animal experiments indicate that hydrochloric acid is responsible for these changes. Treatment should be directed against the bronchiolar spasm and cardiac embarrassment. Oxygen, atropine, epinephrine, and aminophylline will accomplish these objectives. Should cardiac failure develop, rapid intravenous digitalization is indicated. The circulatory burden may be relieved by the application of tourniquets to the extremities to produce the effect of a bloodless phlebotomy.

Aspiration of stomach contents into the lungs may be avoided by withholding oral feeding during labor, by wider use of local anesthesia when feasible, by alkalization of the stomach contents and emptying the stomach prior to the administration of general anesthesia, by competent administration of general anesthesia, and by adequate operating room equipment, including transparent anesthetic masks, tiltable table, suction, laryngoscope, and bronchoscope.

RESPIRATORY DEPRESSION

Respiratory paralysis is more common now than it was when ether was almost the sole general anesthetic agent. Cyclopropane, barbiturates, and morphine all tend to depress respiration. In addition, curare and similar drugs may cause complete respiratory paralysis. Poor exchange causes an increase in carbon dioxide and a decrease in oxygen in the blood, which may lead to irreversible pathologic changes.

Curare effects.—The complications due directly to curare are practically nonexistent but can be the indirect cause of accidents that may prove fatal.[4] The most common incident is respiratory arrest from muscular paralysis. One must be ready to remedy this condition even before giving the injection of curare. Respiratory depression caused by curare will vary with the plane of anesthesia and the percentage of carbon dioxide in the anesthetic mixture. It varies also with the actual muscular resistance of the patient. Other complications following the injection of curare are salivation, bronchospasm, and laryngospasm. These reactions occur for one of three reasons: (1) The patient was not anesthetized. (2) The patient was not sufficiently anesthetized. (3) The patient had not been given a preanesthetic dose of atropine or scopolamine. The anesthetics remove the nervous influence from the muscles; atropine and scopolamine paralyze the vagus.

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[3] Mendelson, C. L.: Aspiration of stomach contents into lungs during anesthesia. Am. J. Obst. & Gynec. **41**:191, 1946.

One thing that causes some trouble is the distention of the stomach by the anesthetic gases. This will occur when the rebreathing bag is pressed in the presence of total or partial obstruction of the airway. In distention of the stomach its liquid contents can back up into the pharynx or can be pushed into the trachea and the bronchi by pressure on the bag. Thus liquid can also flow unnoticed into the trachea and cause serious pulmonary complications.

What can be done to prevent or treat these difficulties? First, atropine or scopolamine must be administered preoperatively to inhibit the vagus and prevent abundant secretions and spasms of the bronchi. The anesthetist must necessarily have ready for immediate use an efficient apparatus to give artificial respiration by positive pressure. Curare must be given in fractional but sufficient doses. When the minute volume exchange is diminished, one must assist respiration to an adequate degree to maintain sufficient oxygenation and carbon dioxide elimination. Intratracheal intubation is almost obligatory. Large doses of curare are to be avoided with ether anesthesia, in the presence of shock, and at the end of anesthesia. In postoperative asthenia or asphyxia the minute volume exchange must be maintained.

Even without the administration of curare, spasms, distention of the stomach, bronchial aspiration of fluids, carbon dioxide retention, asphyxia, and shock can occur. But the paralyzing action of curare may give the anesthetist a false sense of security and an erroneous interpretation of the course of anesthesia.

Carbon dioxide shock.—The deleterious effects of carbon dioxide retention secondary to respiratory depression are now recognized. In 1947 Dripps[5] reported the results of his investigation of the etiology of the decrease in blood pressure not infrequently noted at the conclusion of cyclopropane anesthesia. The usual sequence of events is as follows: Blood pressure during anesthesia is elevated above the preoperative level. When the mask is removed, both systolic and diastolic pressures decrease, the rate and extent of this decline being variable. In those patients showing an immediate and precipitous decrease in blood pressure, the skin becomes clammy and the pulse of poor volume, and emergence delirium is profound. This is the condition to which the term "cyclopropane shock" has been applied. The term "carbon dioxide shock" is more pertinent, as will be shown.

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[4] Hudon, F., and Beaudoin, R. A.: Problems encountered with administration of curare in anesthesia. Anesth. & Analg. **26**:164, 1947.

[5] Dripps, R. D.: The immediate decrease in blood pressure seen at the conclusion of cyclopropane anesthesia: "cyclopropane shock." Anesthesiology **8**:15, 1947.

Certain facts seemed to fit together to provide a logical explanation for the phenomenon. It has been established that cyclopropane anesthesia is associated with a respiratory acidosis, which is ascribed to the accumulation of carbon dioxide. Secondly, it is known that sudden cessation of rebreathing is accompanied by a prompt decrease in the blood pressure level, diastolic pressure being decreased more than systolic pressure. Finally, it has been demonstrated that loss of carbon dioxide is often associated with a diminution in blood pressure in anesthetized man and animal. It is apparent that the pressor mechanisms are sufficiently active to maintain the nervous control of the cardiovascular system unless they are partially or completely inactivated by a depressant drug.

The hypothesis was thus formulated that the rise in blood pressure or the maintenance of circulation under cyclopropane anesthesia was related to carbon dioxide retention secondary to the depressant action of the drug on respiration. When the respiratory depressant was removed at the conclusion of the anesthesia, an elevated carbon dioxide tension in the arterial blood would diminish, and blood pressure would also decrease. The results of clinical studies present evidence in favor of the hypothesis. The condition occurs following any anesthesia in which prolonged respiratory depression has been a feature, more particularly after the administration of pentothal sodium and curare.

Certain practical considerations arise if this theory is proved correct. First, the nature and amount of the preoperative narcotic become important. Second, it is apparent that the sequence of events leading up to this postanesthesia hypotension is more the fault of the anesthetist than the anesthetic. Third, some clinicians have learned to minimize the decrease in blood pressure after cyclopropane anesthesia by utilizing semi-open technics with rapid flows of nitrous oxide-oxygen during the last five to fifteen minutes of prolonged cyclopropane anesthesia. Fourth, it might be of interest therapeutically to attempt to control this hypotensive reaction by using carbon dioxide inhalations during the period of emergence from anesthesia. Treatment of this condition consists essentially of its prevention through maintenance of adequate respiratory exchange.

RESPIRATORY RESPONSES UNDER BARBITURATE ANESTHESIA

Depression of respiration is the foremost effect of pentothal sodium. The degree of depression is directly proportional to the size of the dose administered and the rapidity of intravenous injection. The drug may cause complete respiratory arrest, which may result in death from asphyxia.

Acute respiratory depression has usually been attributed either to overdosage or to some peculiar pathologic condition on the part of the patient. The explanation of acute respiratory depression and failure under barbiturate anesthesia may not be quite so obvious.[6]

Variations in oxygen supply and carbon dioxide content of the tissues and blood can exert a powerful influence on the responses resulting from the administration of barbiturates. Low oxygen tension may itself exert a depressing effect, which, when added to the depressant effect of the barbiturates, may lead to death. The carotid and aortic mechanisms, which are activated by low concentrations of oxygen in the blood, may be depressed by a high tension of oxygen, and respiratory depression may occur. In other words, it has long been recognized that the elimination of the reflex activity of the carotid sinus and aortic nerves by adequate tensions of oxygen can be fatal. In barbiturate anesthesia, even if relatively small doses have been administered, the sensitivity of the respiratory center to its normal stimulant, carbon dioxide, is diminished and finally may be lost. Under these conditions the accumulated carbon dioxide may act as a serious respiratory depressant. Here again there is an accumulative effect from the depressing effect of a high concentration of carbon dioxide plus that of a barbiturate. If this high concentration of carbon dioxide is associated with a low concentration of oxygen, the danger becomes more acute than ever. It was on the basis of these deductions that certain deaths that occurred without warning under barbiturate anesthesia were explained.

The use of barbiturates is contraindicated in conditions in which the concentration of oxygen in the blood may be low or the concentration of carbon dioxide high, since disastrous results may follow. It was also shown that respiratory depression and failure could result in the presence of a small elevation of pressure in the airway plus the administration of 100 per cent oxygen owing to the activation of vagus reflexes. It was observed that adequate pulmonary ventilation as well as good color of the blood is very important to prevent carbon dioxide from accumulating in the tissues, and that the use of synthetic carbon dioxide as a respiratory stimulant is contraindicated.

The beneficial effects of administration of oxygen during barbiturate anesthesia are apparent, particularly when cyanosis is present. One must keep in mind the dangers that can occur from the accumulation of a high tension of carbon dioxide or the temporary masking of serious depression by a high tension of oxygen. This investigation brings out particularly the dangers of attempting to stimulate a depressed or arrested respiration as a result of barbiturate anesthesia by the addition of synthetic carbon dioxide when the respiratory center has already been depressed or paralyzed by the accumulation of carbon dioxide and by a barbiturate.

SUMMARY

Aside from certain precautions or limitations that apply in the

(Continued on page 27)

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[6] Adams, R. C.: *Intravenous Anesthesia* (New York: Paul B. Hoeber, Inc., 1944) pp. 461-465.

Blood Pressure during Anesthesia

Seymour Alpert, M.D.*
Washington, D. C.

In any discussion of blood pressure during anesthesia there are at least five important considerations, all of which influence the status of the blood pressure during a surgical operation. The first of these is the condition of the patient's circulatory system, and in this connection it is essential to know the patient's usual blood pressure as well as related data from the history and physical examination. The second consideration is the type of operation to be performed in relation to trauma and blood loss anticipated and the amount of muscular relaxation needed. The qualifications of the surgeon are also a factor, for the speed of the surgeon, whether or not he handles tissues gently, and the amount of relaxation he demands can all influence the status of the patient's blood pressure. Fourth is the type of anesthesia selected and the agents employed, and the anesthetist should know the pharmacologic action of the agents used for general, intravenous, spinal, and local anesthesia in relation to their possible effects on blood pressure. The final consideration is the anesthetist, whose management of the anesthesia plays an important part in the maintenance of a satisfactory blood pressure.[1]

What is meant by the term "blood pressure?" Blood pressure, which is measured in millimeters of mercury, is the amount of lateral pressure exerted by the blood on the vessel wall. A blood pressure of 120 mm. Hg systolic and 80 mm. Hg diastolic may be used as a so-called standard. The systolic pressure of 120 mm. Hg represents the maximal pressure and corresponds to the first sound heard through the stethoscope, which occurs synchronously with the contraction, or systole, of the ventricle. The diastolic pressure of 80 mm. Hg is the minimal pressure and is measured at the point at which the sound totally disappears; it corresponds to the end of the resting phase, or diastole, of the cardiac cycle. The mean pressure in this example would be 100 mm. Hg and is the sum of the systolic and diastolic pressures divided by two. The pulse pressure in this example would be 40 mm. Hg, or the systolic pressure minus the diastolic pressure. The pulse pressure is the most important figure.

Read before the Carolinas-Virginias Assembly of Nurse Anesthetists, Roanoke, Va., April 25, 1952.

*Associate Professor of Anesthesiology, George Washington University School of Medicine.

[1] Best, C. H., and Taylor, N. B.: *The Physiological Basis of Medical Practice,* ed. 5. (Baltimore: Williams & Wilkins, 1950) pp. 138-343.

A common fallacy is that a normal systolic blood pressure for a person is equal to 100 plus his age, whereas, for example, a normal blood pressure for a person aged 50 is 130 mm. Hg systolic and 86 mm. Hg diastolic. For a person aged 60 it is 135 mm. Hg systolic and 89 mm. Hg diastolic. By definition hypertension is any systolic blood pressure over 150 mm. Hg and any diastolic blood pressure over 90 mm. Hg. Hypotension is by definition any systolic blood pressure below 100 mm. Hg.

FACTORS AFFECTING BLOOD PRESSURE

There are five main factors affecting blood pressure[1]: The first is pumping action of the heart, which determines the output of the heart per minute volume. The peripheral resistance is an important factor, since dilatation of arterioles, particularly in the splanchnic area, can accommodate all the blood in the body. When such dilatation occurs during spinal anesthesia or shock, blood pressure may be unobtainable. The quantity of blood in the arterial system affects blood pressure and is determined by loss of blood through hemorrhage, loss of plasma through burns, and loss of fluids through sweating and dehydration. To maintain blood pressure in each instance the blood, plasma, or body fluids lost must be replaced. The type of replacement therapy for loss of fluids is determined by the composition of the fluids lost. If the principal loss is of salt, saline solution only should be given. Glucose, 5 or 10 per cent solution in distilled water, 10 per cent Travert solution, Ringer's solution, lactate solution for replacement of loss of duodenal fluids, and potassium solution may be indicated in special cases. The greater the frictional resistance of the blood, the less the amount of blood that will pass through the vessels per unit time. Consequently, the viscosity of the blood affects blood pressure. For example, the viscid condition of the blood in polycythemia accounts for the slowing of the circulation in that disease. Finally, the elasticity of the arterial walls and the peripheral resistance are determinants of diastolic blood pressure.

CAUSES OF HYPOTENSION

Blood pressure may be decreased as a result of underlying disease, and it is usually decreased in the patient with hypothyroidism, debility, or cachexia. It should be remembered that a systolic pressure of 100 to 120 mm. Hg represents hypotension in the patient with severe hypertension.

Hemorrhage is a second important cause of hypotension. In the presence of bleeding the decreased venous return causes a decrease in cardiac output, and compensatory vasoconstriction may temporarily mask a decrease in blood pressure. When hemorrhage occurs, blood should be replaced as it is lost. Even though a satisfactory increase in blood pressure results from the replacement of blood lost, the peripheral circulation should be checked in order to make sure that vasoconstriction is not an influencing factor. Otherwise, the administration of more blood may be needed. For major surgical operations at least two needles, preferably 17 or 18 gage, should be in place for intravenous therapy. When massive hemorrhage occurs, the coronary and cerebral circulation must be supported immediately, and intra-arterial transfusion with the blood under positive pressure of 100-200 mm. Hg should be considered.

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[1] Best, C. H., and Taylor, N. B.: Op. cit.

The stimulation of reflexes during an operation is a third important cause of hypotension. The mechanism may be trauma, such as attends the amputation of a leg, in which the nerve impulses travel along afferent nerves and lead to inhibition of the vasomotor center. The hypotension may be severe despite little or no blood loss. Stimulation of the carotid sinus reflex from pressure of a finger or the head strap on the carotid sinus, stimulation of the celiac plexus reflex during operations on the gallbladder and stomach, and stimulation of reflexes during traction—particularly during pelvic operations—can also lead to the production of hypotension.[2] Hypotension from the stimulation of periosteal and pleural reflexes during resection of ribs in thoracic operations when the anesthesia is light may be prevented by local infiltration of procaine.

The character of the anesthesia, such as deep anesthesia with central and peripheral depression, can also contribute to the production of hypotension. In spinal anesthesia arteriolar dilatation eliminates the compensatory mechanism of vasoconstriction. The higher the level of spinal anesthesia, the greater the number of sympathetic nerves involved and the greater the decrease in blood pressure. In treating such a decrease in blood pressure with sympathomimetic agents—ephedrine, methoxamine, desoxyephedrine, neosynephrin, and epinephrine[3,4]—the drugs should be administered in minute doses intravenously. It is better to repeat the medication than to give too much in one dose. An excellent vasopressor is norepinephrine, 4 cc. or 4 mg. in 500 or 1,000 cc. fluid, given intravenously. When this drug is given, the effect on blood pressure should be carefully watched. Some anesthetists prefer neosynephrin, 2 cc. of a 1 per cent solution in 500 cc. of fluid. A decrease in blood pressure can also occur after cyclopropane anesthesia, when the elimination of carbon dioxide removes the stimulus that has maintained the blood pressure during the anesthesia. Likewise, in the presence of anoxia the initial increase in blood pressure is followed by hypotension.

A fifth cause of hypotension is changing the position of the patient during anesthesia. A decrease in blood pressure is particularly likely to occur when the patient is changed from the lithotomy position after perineal prostatectomy or anterior-posterior repair and vaginal hysterectomy. A decrease in blood pressure often occurs when the patient's legs are lowered at the conclusion of an operation. If the legs are carefully wrapped with elastic bandages, this decrease in blood pressure can be prevented.

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[2] Scurr, Cyril F.: Significance of blood pressure during anesthesia. Anesth. & Analg. **30**:211-221, 1951.

[3] Poe, Mary Frances: Use of methoxamine hydrochloride as a pressor agent during spinal analgesia. Anesthesiology **13**:89-93, 1952.

[4] Kreul, William, and Orth, O. S.: Treatment of the hypotensive states of spinal analgesia with dilute neosynephrin solution. Anesthesiology **12**:455-464, 1951.

Prolonged hypotension is dangerous, and the most important consideration in treatment of the condition is the prompt determination of the cause.

Certain new technics of anesthesia are specifically designed to create a hypotensive state, and they should be used very carefully if at all. Among these are Gillies' technic of high spinal anesthesia for major operations, in which the systolic pressure is maintained below 80 mm. Hg, the head lowered, and oxygen administered; the use of drugs such as pentamethonium iodide and hexamethonium to produce hypotension during the fenestration operation; and the technic of blood removal, developed at the Cleveland Clinic for operations in which the systolic blood pressure is maintained below 80 mm. Hg when massive blood loss is expected.[5]

Causes of Hypertension

A number of pre-existing conditions may account for hypertension in the surgical patient and include hyperthyroidism, pregnancy, pheochromocytoma, essential hypertension, malignant hypertension, brain tumor, and various forms of renal disease. Consequently, it is important to know the patient's normal blood pressure and to maintain that pressure throughout the operation.

A common cause of an increase in blood pressure during anesthesia is carbon dioxide accumulation. The condition can be corrected by establishing a patent airway, by the insertion of an intratracheal tube if necessary. The anesthetist should also make sure that the soda lime in the carbon dioxide absorber is not exhausted. Light anesthesia permitting the stimulation of reflexes in the operative field can also produce hypertension. Carbon dioxide retention may elevate the blood pressure during cyclopropane anesthesia.

Certain operative conditions in addition to anesthesia may be responsible for an increase in blood pressure. When air is injected for a ventriculogram, the blood pressure may increase alarmingly if the air is not removed through a needle to the ventricle of the brain or through a small catheter, which is left in the ventricle and clamped, the clamp being released as the blood pressure increases. Hypertension can also be produced by the overzealous replacement of fluids lost; in this instance the venous pressure particularly is increased as manifested by distention of superficial veins. Alarming increases in blood pressure can result from overadministration of a vasopressor drug with solutions used for local anesthesia. An optimal proportion is two drops of 1:1,000 epinephrine in 1 ounce of the anesthetic solution or six drops to 100 cc. of the solution.

Severe hypertension is dangerous and is attended by the ever present possibility of a cerebral vascular accident. A simple measure is to break a cotton-covered perle of amyl nitrite and put it into an empty ether absorber bottle or breathing bag for the patient to inhale. This will usually result in a prompt decrease in blood pressure. Carbon dioxide ac-

(Continued on page 27)

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[5] Hale, D. E.: Controlled hypotension by arterial bleeding during operation and anesthesia. Anesthesiology 9:498-505, 1948.

Carbon Dioxide

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Most of us learned in our training days that almost all difficulties occurring during anesthesia can be solved or prevented by attention to three things: (1) an open airway, (2) adequate oxygen, and (3) adequate removal of carbon dioxide. However, it always seemed to be the first two items that were stressed. Indeed, the gas machines actually had tanks of carbon dioxide on them, and there were means of cutting carbon dioxide absorbers out of the system. What, then, is bad about carbon dioxide retention? In seeking an answer to this question, I have formed a firm conviction that there is a great deal that is bad.

Today we think less in terms of "How much will the patient stand?" and more in terms of "How close to normal can we maintain the physiology of the patient?" If we will accept the thesis that, if we can keep the physiologic status of the patient undergoing anesthesia the same as when he is lying comfortably in bed, we have done him no more harm than when he is in bed, then it follows that any effort expended towards preserving his normal status is not only desirable but obligatory. I believe that this is just as important with respect to carbon dioxide as it is with respect to some of the more obvious factors, such as oxygen supply, blood pressure, and pulse rate. Specific reasons will be given in the following discussion.

ACIDOSIS

Many anesthetic agents and procedures produce a metabolic acidosis of significant degree, probably by interference with glucose metabolism and by increased production of lactic acid. The starvation and dehydration that are demanded so vehemently for satisfactory operating conditions are sufficient in themselves to produce deviations. This situation is further aggravated by a superimposed respiratory acidosis whenever carbon dioxide is allowed to accumulate. What is bad about acidosis? An uncompensated acidosis actually alters the hydrogen ion concentration of the blood. It is reasonable to assume that many of the enzyme systems, which the body uses in its metabolism, operate optimally at the normal hydrogen ion concentration of the blood, and any departure from that norm will tend to slow down the process.

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Furthermore, if acidosis develops, the hydrogen ion concentration is just one more factor that must return to normal in the already overburdened recovery period.

ALTERATIONS IN BLOOD PRESSURE

All anesthetists are aware of the pronounced increase in blood pressure that takes place as a result of carbon dioxide accumulation and of the compensatory decrease that occurs afterwards. If we accept the objective of striving to maintain normal physiology at all times, such deviations from normal in any patient should be condemned—even though "he can take it." Moreover, these alterations can be distinctly dangerous to life in the patient with sclerotic or weakened vessels in his brain or heart. In this respect, when I have a chance to preach to internist consultants, I say, "Don't tell us what agents to use for the patient who has limitations from some disease process. We are quite capable of 'bouncing' the pressure around with any agent or procedure. Rather, tell us what is the normal range that we should strive to maintain for this patient."

CYCLOPROPANE SHOCK

"Cyclopropane shock" is generally accepted as being a phenomenon of carbon dioxide retention. The use of the closed system and the depressed respiration that usually attends cyclopropane anesthesia almost inevitably result in chronic accumulation of carbon dioxide. During recovery, as the minute volume is increased, the excess carbon dioxide is blown off, and a compensatory hypotension results. This causes a great deal of alarm in the recovery room, and the anesthesia staff is called in a hurry to help revive the patient who is in shock. The feature by which this situation is distinguished from one in which there actually is superimposed shock is the lack of acceleration of the pulse rate.

INCREASED MUSCLE TONE

Much emphasis has been placed on the tetany of alkalosis resulting from hyperventilation and carbon dioxide deficit in the patient with anxiety. Not so generally known is that carbon dioxide excess, even of moderate degree, consistently causes an increase in muscle tone, rigor, and athetoid movements. It is commonly observed that during induction of anesthesia with inhalation agents, when the carbon dioxide absorber is disconnected, the patient quickly develops twitching motions in his fingers and a rolling motion in his shoulders. As induction progresses it is sometimes noted that even with the patient in second plane anesthesia his jaw cannot be forced open for the insertion of an airway until the absorber is placed in circuit, whereupon the patient quickly relaxes, and the airway is inserted with ease.

The situation also arises in which a patient is anesthetized to a degree that by all the signs should be sufficient for cholecystectomy, for example, but the surgeon complains of the lack of relaxation. If the anesthesia is deepened, the situation only gets worse, and in addition the patient begins to show signs of distress. If by force of necessity, the anesthesia is lightened, the anesthetist may be surprised to hear the surgeon say, "That is much better now." The anesthesia has been lightened sufficiently for the minute volume exchange to return to normal and blow off carbon dioxide that had accumulated and was increasing muscle tone. The decreased respiratory exchange of deep anesthesia can cause carbon dioxide retention sufficient to overcome the relaxed state that should be present. In addition, this carbon dioxide excess aggravates the jerking motion of the diaphragm, which is so annoying to a surgeon operating in the upper abdomen. This situation pertains to the use of curare as well as to the use of inhalation agents alone. Since relaxation is one of the prime objectives of anesthesia, certainly carbon dioxide excess is deleterious if it inhibits the anesthetist's efforts in that direction.

As a corollary to this I have observed that when the abdominal muscles are not quite sufficiently relaxed for the surgeon to close the incision readily and I am reluctant to give additional curare or deepen the anesthesia this late in the operation, adequate relaxation can frequently be produced by hyperventilating the patient vigorously.

TREMORS AND PENTOTHAL SODIUM

Although there are eminent authorities who disagree with me, the occasional exhibition of rigor and tremors by patients who have had pentothal sodium for anesthesia is best explained on the basis of accumulation of carbon dioxide. As I see it, the cause is subnormal exchange due to the effect of pentothal sodium on the respiratory center. There is a chronic, low grade accumulation of carbon dioxide during the anesthesia, the effects of which are somewhat masked by anesthesia. As the patient is recovering, these effects are unmasked, and the same rigor and tremors are seen that are observed during a slow induction of anesthesia in which carbon dioxide is used. One can usually say with confidence that the patient will relax within twenty minutes, during which time the respiratory exchange is increasing and the carbon dioxide level is returning to normal.

TREATMENT OF RESPIRATORY OBSTRUCTION WITH OXYGEN

I have vivid memories of a patient who underwent a radical dissection of the neck and was bandaged rather extensively for compression of the skin flaps. After he had been back on the ward for awhile, someone noted that he was cyanotic, and oxygen given by nasal catheter corrected the cyanosis completely. However, during the night the patient died from pulmonary edema. Obviously, the treatment of respiratory obstruction is not merely to provide oxygen but to remove the obstruction. Otherwise, retention of carbon dioxide increases, respiratory efforts against the obstruction are increasingly stimulated, and pulmonary edema is the inevitable result if the extreme negative pressure is allowed to continue. Carbon dioxide retention is not only bad, it also may be fatal.

ETHER CONVULSIONS

Ether convulsions, or, more properly, convulsions under anesthesia, since the same condition has been described when agents other than ether have been used, are probably not a specific entity. However, the fact remains that patients may die from convulsions that develop under anesthesia. In almost all of the cases that ended fatally, certain factors were present. It was hot in the operating room, the patient had a high fever, and there was an excess of carbon dioxide in the system. While these cases are rare, the mere possibility of their existence is ample reason to bend every effort towards keeping carbon dioxide levels normal in all patients.

ARRHYTHMIAS

Conroy[1] in electrocardiographic studies showed the occurrence of a shifting pacemaker, ventricular ectopic beats of multiple foci, and even ventricular tachycardia from such maneuvers as breath-holding during induction, breath-holding after insertion of an intratracheal tube, an obstructed airway, and diminished respiratory exchange from deep anesthesia. Hypoxia was fairly well ruled out as a cause by the administration of a great excess of oxygen in most cases. These arrhythmias were produced with equal ease whether the patient was receiving cyclopropane, nitrous oxide, or ether. Thus, by a process of elimination, carbon dioxide remained the most likely cause for these difficulties. This study confirmed laboratory evidence that carbon dioxide excess increases ventricular irritability and is a contributing factor in heart block. Conroy implied that arrhythmias commonly blamed on the use of cyclopropane might be due solely to carbon dioxide retention.

USE AND ABUSE OF CARBON DIOXIDE

If carbon dioxide retention can be so bad, why is the agent commonly available in every hospital and on the gas machines? When is it permissible and when not permissible to give carbon dioxide?

I do not believe that carbon dioxide in excess is ever *needed*, and I should be quite content if none were available. However, the factor that determines whether it is *permissible* to use an excess of carbon dioxide is duration of use. There is no particular harm in using an excess of carbon dioxide for periods up to five minutes in situations such as the following ones:

1. It is reasonable to use carbon dioxide to speed induction. Undoubtedly, the reduced chance of vomiting is worth the minor disturbance.

2. When a patient is nauseated postoperatively or during spinal anesthesia small amounts of carbon dioxide may help relieve this unpleasant situation.

3. Regular inhalations of carbogen postoperatively undoubtedly help prevent respiratory complications. I believe that the chief value of such therapy lies in giving the nurses a specific instruction for a "stir-up" routine. If instructions are given to "encourage deep breathing, turn frequently, or 'stir-up' routine," the interpretation and effectiveness will vary tremendously with different nurses. However, instruc-

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[1] Conroy, W. A.: Cardiac arrhythmias during anesthesia. Unpublished manuscript.

tions for "carbogen inhalations for 3 minutes q. ½ hr." leave little room for individual interpretation.

4. It is permissible to disconnect the carbon dioxide absorber for a short period while attempting to reinstitute respiration in a patient who has been apneic from the effects of curare and hyperventilation.

Carbon dioxide excess must not be used in routine situations, for it is in such situations that all the evils mentioned arise. Many gas machines have graded controls so that the carbon dioxide absorber may be turned ¼, ½, or ¾ on. I have mentioned circumstances in which it might be reasonable to turn a carbon dioxide absorber off for a short time; I cannot conceive of any situation in which it is justifiable to have a carbon dioxide absorber part way on. The routine use of carbon dioxide excess to increase a lowered blood pressure is entirely unjustifiable. One must rather correct the physiologic conditions that have caused the hypotension. The routine use of carbon dioxide excess to increase ventilation in a depressed patient is equally culpable.

There is no place for use of carbon dioxide excess in resuscitating the apneic patient. Here I am at variance with such authorities as Flagg and Goodman and Gilman. However, it is obvious that the apneic patient is suffering from two catastrophies, oxygen lack and carbon dioxide excess. Giving carbon dioxide in such a circumstance seems just as illogical as decreasing the amount of oxygen in the inspired air. If carbon dioxide excess were of any value in initiating respiration, the patient would have already accomplished this by himself. When carbon dioxide reaches a concentration of 10 per cent, the point of maximal stimulation is exceeded, and it becomes a narcotic and in higher concentrations an anesthetic. If a mixture containing 7 per cent carbon dioxide is given, and the patient has built up an excess of only 3 per cent, no good is being done by administration of the mixture, and actually the patient is being depressed.

SUMMARY

Carbon dioxide excess is deleterious because (1) it aggravates the tendency towards acidosis, (2) it causes severe alterations in blood pressure, (3) it increases muscle tone, (4) it may be the cause of tremors during pentothal sodium anesthesia, (5) it may cause pulmonary edema in the patient with partial respiratory tract obstruction, (6) it contributes to the occurrence of convulsions under anesthesia, and (7) it contributes to the production of cardiac arrhythmias.

There are a few special situations in which carbon dioxide might reasonably be administered for periods under five minutes. Carbon dioxide excess should not be used (1) in any circumstance for longer than five minutes or (2) for resuscitation.

Problems of the Anesthetist in Intrapleural Surgery

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The discovery and perfection of recent technics in the field of intrapleural surgery have been made possible by advances in the field of anesthesia. The responsibilities of the anesthetist in many thoracic operations are far greater than in other types of surgery. Slight disturbances in the conduction of anesthesia that may have little detrimental effect during an abdominal operation may have a profoundly adverse effect during a thoracic procedure. Thoracic operations are usually performed upon patients in whom the vital capacity is altered and upon those suffering from pulmonary neoplasms, debilitating chronic diseases, such as tuberculosis, or chronic suppurative diseases of the lung, such as bronchiectasis and abscess. Because of the general condition of the patient it is obligatory not to permit anoxia or impaired pulmonary ventilation.

The goal of the anesthetist is to provide a satisfactory state of anesthesia so that the surgeon may perform the required operative procedure with the least possible difficulty and with a minimal amount of alteration in physiologic function. Adequate pulmonary ventilation at all times is essential, and any failure in this regard is serious.

In excisional surgery of the lung, as well as in operations upon the esophagus and heart, the patient is subjected to the hazards of an open pneumothorax, stimulation of the mediastinum, cardiac arrhythmias, and dangers of suffocation resulting from accumulated bronchial secretions expressed from the lung during the operation. The complications facing the anesthetist in intrapleural surgery are many and varied.

PREMEDICATION

There are various schools of thought regarding premedication for patients about to undergo any type of thoracic operation. Some anesthetists believe that premedication given in the usual dosage one hour prior to operation will depress the cough reflex and allow the collection of secretions, which will cause trouble during induction and maintenance of anesthesia.

It has been suggested that coughing may be prevented by omitting all preoperative medication and encouraging the patient to continue raising all secretions until he arrives in the operating room. After the patient is in position on the operating table, morphine sulfate and atropine sulfate in adequate dosage are given intravenously. In planning premedication for thoracic operations respiratory depression must be definitely avoided, and the accumulation of bronchial secretions must be lessened if possible.

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METHOD OF ANESTHESIA

The use of the closed system with the employment of an intratracheal tube appears mandatory in operations in which the pleural cavity is opened. It often becomes necessary to maintain positive pressure either continuously or intermittently for protracted periods. When acute respiratory failure occurs in the patient subjected to operation, rhythmic insufflation of oxygen through the intratracheal tube is often a lifesaving procedure. Even in cases of cardiac standstill requiring manual cardiac massage, attempts to revive the heart will be futile unless high concentrations of oxygen can be maintained in the coronary arteries supplying the myocardium. This is best accomplished by adequate artificial pulmonary ventilation with pure oxygen.

The anesthetist must be prepared to maintain an airtight system, either by use of an inflatable cuff or packs. It has also been shown that in choosing an intratracheal tube and suction catheter, the anesthetist must remember to employ a suction catheter large enough to remove purulent material. This catheter, however, must not be so large as to prevent free entrance of air around the suction tube. Pulmonary collapse may result from the negative pressure produced by suction in an almost completely closed system. Some suggest that the suction be turned on after the catheter has been introduced. It is believed that the removal of oxygen by suction sometimes abruptly causes anoxia.

CHOICE OF ANESTHETIC AGENT

The choice of anesthetic agent varies with the type of operation to be performed, the skill of the anesthetist and the surgeon, and the length of operation.

Some anesthetists advocate cyclopropane as the ideal agent for anesthesia for thoracic operations. Others prefer ether with nitrous oxide-oxygen. The use of pentothal sodium-curare-ether anesthesia for thoracic surgery has been reviewed many times.

The main points for consideration in choosing an anesthetic agent for thoracic surgery are: (1) that an adequate exchange of respiratory gases be provided, (2) that a smooth induction be obtained with quiet, regular respiration to prevent coughing during induction; (3) that early recovery of an effective cough mechanism be sought; (4) that there be minimal postanesthesia complications; (5) that provision be made for facile intubation and tracheobronchial aspiration.

The circulatory and reflex effects of the various combinations of anesthetic agents have been compared frequently. Cyclopropane has many qualities that recommend it for intrathoracic operations, but certain undesirable results have been observed. When cyclopropane was used alone, cardiac arrhythmias were much more frequent than when other agents were used. Cardiac arrest during traction on the hilus occurred in more reported cases. A decrease in blood pressure and an increase in pulse rate of varying degree appeared more common during prolonged cyclopropane anesthesia. Our recommendation has been the administration of pentothal sodium intravenously while the patient is allowed simultaneously to breathe carbon dioxide in oxygen to establish a good hyperpnea and to facilitate intubation.

The advantages of pentothal sodium induction with ether maintenance have often been discussed. It has been pointed out that with depressed respirations paradoxical breathing decreases and that to-and-fro movements of the mediastinum are easily controlled. Hemorrhage also decreases since pentothal sodium does not cause peripheral vasodilation.

It is imperative that the anesthetist maintain a suitable depth of anesthesia and also an adequate respiratory exchange with a minimum of effort on the part of the patient, even though the mechanism of respiration is materially altered by removal of ribs or the opening of the thoracic cavity. Many patients will have a lowered vital capacity from pulmonary disease, such procedures as the creation of an artificial pneumothorax, or phrenic nerve paralysis on the contralateral side. This fact makes it imperative to maintain adequate oxygenation at all times. One must also watch for evidence of increased carbon dioxide tension. This can be controlled by gentle pressure on the rebreathing bag during inspiration.

Pentothal sodium as an anesthetic agent for thoracic operations has several advantages. For the patient it provides a pleasant induction with a minimum of nausea and vomiting in the postoperative period. It permits the surgeon to use an electric cautery, and hence the time of operation is materially shortened. There is no increase in bleeding as a result of vasodilatation. For the anesthetist it makes possible a smooth rapid induction, and with the use of curare and a local anesthetic spray the cough reflex is inhibited. It also permits the plane of anesthesia to be deepened rapidly whenever necessary. Frequent aspiration of the bronchial tree is possible without fear of lightening the anesthesia or danger from the release of an explosive mixture. Excitement during induction and recovery is minimized.

Breathing is quiet, somewhat shallow, and only slightly increased in rate and consequently there is less likelihood that purulent material will be dislodged from the diseased portion of the lung. With the use of pentothal sodium there is little change in blood pressure or heart rate. Recovery is rapid, and patients are more co-operative upon reacting.

Pentothal sodium, however, has some disadvantages. It is a severe respiratory depressant if used too long. Without adequate use of curare derivatives the throat reflex remains active, and cough, hiccough, and laryngospasm are likely to occur, especially if there is excess secretion in the trachea or nasopharynx. Pentothal sodium induction with ether maintenance seems to prevent the occurrence of the aforementioned complications.

In the choice of an agent important points are the maintenance of adequate oxygenation and the prevention of cough. Among the special problems encountered in choosing an anesthetic agent for a thoracic operation are those related to the patient, namely, a reduced vital capacity, which necessitates a potent anesthetic agent to maintain adequate anesthesia and a high oxygen concentration to sustain life; the presence of copious bronchial secretions; and the presence of anemia with the prospect of blood loss. One must also bear in mind the untoward symptoms resulting reflexly from traction on the hilus of the lung and frequently the occurrence of mediastinal swing. Furthermore, the subject for operation is often a poor surgical risk because of protracted illness or superimposed anemia or toxemia. The choice of agent has been widely discussed by various authors, yet each case is a law unto itself. All agents have advantages and disadvantages.

POSITION

Many problems face the anesthetist about to assist with an operation within the pleural cavity. One of these is the matter of positioning. The position of the patient during an intrapleural operation often creates a grave problem for the anesthetist. The choice of position depends upon the surgeon's wishes; however, in some cases the general condition of the patient may warrant otherwise.

In the past the conventional lateral position and posterior approach were favored over the anterior approach, because of a greater spread of the thoracic cage and the shorter distance to the hilus. However, the lateral position has definite disadvantages. Those of interest to the anesthetist are (1) that the excursions of the thoracic cage on the sound side might be impaired by the weight of the body and (2) that a pronounced imbalance between thoracic cage excursion and diaphragmatic movement of the dependent side might seem to increase the respiratory power and at the same time diminish the expelling force. Another disadvantage to the lateral position is the fact that the drainage by gravity of secretions and debris from the affected lung to the opposite lung is favored, thus enhancing atelectasis.

The prone position has been proved to be more advantageous from several points of view. This position is most favorable for natural drainage of bronchial secretions, and the flooding of the contralateral lung is greatly lessened. The attainable range of thoracic cage and diaphragmatic excursion is far greater than is possible in the lateral position. The weight of the lung allows it to fall forward to eliminate the necessity for various means of traction during dissection. Cardiac irregularities, bradycardia, and cardiac standstill have been minimized as complications; this may be due to avoidance of hilar traction during dissection. The use of the prone position has been favored by the perfection of several operating tables with attachments. However, the sternal rest must be used with care.

Regardless of the position chosen, it is of prime importance that the head be lower than the chest, to avoid danger of air embolism in cerebral vessels and to reduce the danger of aspiration.

ANOXIA

The word anoxia signifies a deficiency in the supply of oxygen available to the cells of the body. The cells that earliest suffer irreparable damage are those of the cerebral cortex; therefore cerebral anoxia is significant. The signs of cerebral anoxia are known to all anesthetists.

During thoracotomy the ipsilateral lung is collapsed, and the blood flowing through it, which is not being oxygenated, constitutes a shunt of venous blood to dilute the arterial blood from the functioning contralateral lung. The burden of oxygenation of the blood, therefore, falls on the contralateral lung, and, particularly if it is diseased, anoxic anoxia might be expected to develop.

When a patient is under general anesthesia, no significant changes in the respiration, pulse, or blood pressure are apparent until a serious degree of anoxia is present, and cyanosis is a late and unreliable sign. In some places an oximeter is employed, and the anesthetist watches the oximeter and supplies positive pressure as indicated.

It has been suggested that in about 50 per cent of the cases a gradual diminution in the efficiency of the contralateral lung is due to increasing atelectasis associated with a progressive shift of the mediastinum. The lung is reexpanded and its function restored periodically by application of a positive pressure of 15 mm. Hg.

The sudden decrease in oxygen saturation associated with bronchial suction is probably due not only to the withdrawal of oxygen but also to a temporary increase in atelectasis from negative intrabronchial pressure. Spasm induced by the irritation of the suction catheter may also be a factor.

EFFECTS OF STIMULATION

Another problem facing the anesthetist during intrapleural operations is the effect of stimulation of the heart, aorta, vagus, and nerves regulating cardiac activity. Because of the proximity of the heart and aorta to the field of operation, the effects of stimulation are at times of major significance. In some patients the heart seems unusually irritable and responds immediately to local stimuli by developing extrasystoles or other manifestations of disturbed rhythm, such as auricular flutter. Sometimes this disturbance may be long continued. It has been found helpful to give intramuscular injections of quinidine or intravenous injections of procaine or to infiltrate the pericardial sac with procaine.

Marked arrhythmias may be observed and are probably due to a reflex disturbance resulting from stimulation of the cardiac regulatory nerves in the region of the aortic arch. Disorders of cardiac function manifested by a decrease in peripheral blood pressure are frequently seen. It has been suggested that, when such a decrease occurs, the procedure should be temporarily interrupted and oxygen given. There is rarely any demonstrable disturbance resulting from stimulation of the vagus during the course of an operation within the mediastinum. The only important effect is activation of the cough reflex, especially when the plane of anesthesia is very light. Infiltration with 1 per cent procaine is helpful.

A careful investigation of cases of cardiac arrest during the course of thoracic operations showed that a state of relative anoxia of the circulating blood was allowed to exist for a prolonged period.

SUMMARY

The management of anesthesia plays an important role in the eventual outcome of thoracic operations. The pathologic process for which surgical therapy is undertaken has already jeopardized cardiorespiratory function, and the condition is usually aggravated by an alteration in dynamics during the course of anesthesia. It is imperative that an additional burden not be placed upon the patient as a result of inadequate pulmonary ventilation, anoxia, or other undue alterations in physiologic function.

Premedication, position, and method of anesthesia along with choice of agent are discussed. Complicating factors are listed.

The seventeenth qualifying examination for membership in the American Association of Nurse Anesthetists will be conducted on Saturday, May 9, 1953.

The deadline for completed applications, including transcripts, is April 4. If application with transcript is received too close to the deadline, the application may not be processed in time for the candidate to be scheduled for this examination. The decision of the Credentials Committee will not be mailed to candidates before April 6.

BLOOD PRESSURE

(Continued from page 16)

cumulation as a cause should be eliminated or corrected. If the hypertension is the result of reflex stimulation during light anesthesia, the anesthesia should be deepened; this is easily accomplished by the administration of pentothal sodium. In attempting to control the hypertension it is just as important to know what not to do as what to do. Pressure on the eyeballs should never be used as a technic to decrease the blood pressure for it may lead to heart block.

SUMMARY

The conditions causing changes in blood pressure during anesthesia and surgery are described. It is essential that the blood pressure be measured at least every five minutes during an operation in order that the beginning of a deviation from the normal may be ascertained. Corrective measures must be taken promptly to re-establish the physiologic circulatory status of the patient.

COMPLICATIONS

(Continued from page 12)

choice of an anesthetic agent, the technic used in administering the anesthetic may be far more important than the choice of the agent itself.

The gravest danger to the patient is the possibility of poor respiratory exchange. Many of the fatal complications produce damage by interfering with transport of oxygen and carbon dioxide in the body.

Conduction Anesthesia and Obstetrics

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Maternal and fetal mortality rates have been greatly reduced in the past ten years. Although there are many reasons for this decrease, anesthesia has played an important role in it. Better anesthesia administered by better trained personnel has contributed to the improvement in many conditions in obstetrics. However, in spite of these advances there still occurs each year in this country a relatively large number of maternal and fetal deaths that are probably directly due to the effects of anesthesia. Greenhill[1] reported that 3.8 per cent of maternal deaths were the result of various forms of anesthesia. Hingson,[2] in a report of a large series of cases obtained from various hospitals about the country, found that many deaths were due to the aspiration of vomitus during general anesthesia. The patients died from chemical pneumonitis or pneumonia that resulted from irritation by stomach contents. Therefore it becomes essential to review frequently the effects of anesthesia in order to widen the margin of safety after anesthesia.

As the anatomy and physiology of the nervous system have become better understood and the pharmacologic actions of anesthetic agents have become better known, conduction anesthesia, such as caudal, spinal, saddle block, and local nerve block, has been more widely used. It can be accurately stated that, in medical centers and hospitals where there are adequately trained anesthesiologists and where supervision of anesthesia is possible, this type of anesthesia has played an important part in the reduction of mortality. Unfortunately, however, accidents from the use of this type of anesthesia have been reported, and it remains our responsibility to continue to improve methods and drugs to make anesthesia safer for the patient. It is the purpose of this presentation to relate our experience at Syracuse Memorial Hospital with conduction anesthesia and report the changes made to increase the safety.

Effect of Anesthesia on Mortality Rate

From 1942 through 1951 there were 21,164 births in the Syracuse

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Read before the Mid-South Assembly of Nurse Anesthetists, Memphis, Tenn., Feb. 13, 1952.

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[1] DeLee, J. B., and Greenhill, J. P.: *Principles and Practice of Obstetrics,* ed. 10 (Philadelphia: W. B. Saunders Co., 1951).

[2] Hingson, R. A.: Newborn mortality and morbidity with continuous caudal anesthesia: Analysis of cases in New York, Philadelphia and Memphis with controls. J.A.M.A. **136**:221-229, Jan. 24, 1948.

Memorial Hospital. During that time there were 16 maternal deaths, 13 of which occurred during the first five year period. This made the maternal mortality rate during the first five years 1.4 deaths per 1,000 births. Although this rate is comparable to the maternal mortality rate for the country as a whole and somewhat better than the mortality rate for New York State, it is still too high. During the past five year period there were 3 maternal deaths, 1 of which might be questioned as a definite obstetric death. This made the mortality rate during those years 0.25 per 1,000 births. This rate, of course, is very low and is one of which the hospital may be proud. Likewise, the fetal mortality rate decreased during the second five year period from 1947 to 1951. For the first five year period the neonatal death rate was estimated to be 23.9 per 1,000 births, while the stillbirth record showed 22.9 deaths per 1,000 births. During the second five year period the neonatal death rate was decreased to 19.5, or a reduction of 4.4 per 1,000 births, and the stillbirth rate decreased 2.3 per 1,000 births. Therefore the over-all picture with respect to fetal and maternal mortality showed a satisfactory reduction. I am sure that this reduction was not entirely due to a change in philosophy of anesthesia but that many other factors were responsible. However, anesthesia must be given a certain amount of credit for this improvement, and it also must be given some credit for the decrease in complications that may not be lethal to the patient but may cause crippling effects.

There was a decrease in the number of cases of postpartum hemorrhage, and there were no deaths from this complication after 1944. Such complications as cardiac disease, diabetes mellitus, lung complications, and postoperative abdominal conditions decreased, and there were no deaths from any of these conditions during the same period. During this time there was a considerable increase in the incidence of prematurity owing to the fact that patients were carried farther into pregnancy than in former years. During the past five year period the mortality rate for premature infants decreased markedly, and fewer complications arose. The incidence of toxemias of pregnancy, which generally account for 25 per cent of maternal deaths, was markedly reduced owing to better and more intensive prenatal care. The control of toxemia during labor was improved by the use of continuous caudal anesthesia. It was noted that the use of continuous caudal anesthesia during labor, when the blood pressure has a tendency to increase, effected a gradual decrease in the blood pressure and by this mechanism prevented recurrence of eclamptic convulsions. Owing to vasodilatation in the kidney effected by continuous caudal anesthesia, the excretion of urine was found to increase while the kidney was under the effect of the caudal anesthesia. Fetal survival rate was higher in the presence of toxemia of pregnancy because of less anoxia, which is created by all types of inhalation anesthesia.

Although we feel that the reduction in the over-all mortality rate and incidence of complications was probably due to better obstetric care, we also believe that, inasmuch as there was a marked increase in the use of conduction anesthesia, better anesthesia played a part in this improvement.

TECHNIC OF CAUDAL ANESTHESIA

The use of caudal anesthesia was started at Memorial Hospital in 1942. Although various technics were used for its administration, we have settled on the catheter method. A no. 16 caudal needle is introduced into the caudal hiatus and a no. 4 urethral catheter is passed through it. Although all sorts of anesthetic drugs have been tested, the best results have been obtained with 1.5 per cent metycaine. Pontocaine with adrenalin was used a few times when a more prolonged anesthesia was desired.

However, in the past five years there has been a change in the philosophy of the use of caudal anesthesia. During the first five years continuous caudal was used for all labors and was administered as soon as the patient was in labor, the cervix was dilated to 3 cm., and the head was engaged. The effect upon the primigravida was dramatic but produced some dangers. The first stage of labor was generally greatly reduced in length, but the second stage of labor in some instances lasted for many hours. Low forceps extraction, rotation from the posterior to the anterior position, either manually or by forceps, and other methods of delivery were many times necessary to complete the delivery. Therefore, during the last five years caudal anesthesia has been used as a terminal anesthesia for the primigravida. Caudal anesthesia is given after the presenting part has been allowed to distend the perineum. We feel that this is the safest approach in this type of case. However, the routine has not been changed for the multigravida, and caudal anesthesia is administered after labor has been established, the cervix is 5 cm. dilated, and the presenting part is engaged. Generally, complete dilatation takes place before the full dose of the drug for caudal anesthesia is administered and the presenting part reaches the outlet. There is no question but that the over-all incidence of operative delivery has increased with caudal anesthesia. However, these operative procedures have mostly been classified as prophylactic low forceps deliveries. The incidence of high forceps and mid forceps delivery has decreased practically to zero. We feel that the increase in prophylactic low forceps deliveries has not affected the condition of the fetus, since the fetal mortality rate has decreased in the face of an increasing operative procedure rate.

DANGERS OF CAUDAL ANESTHESIA

No matter what type of anesthesia is used, there is always a possibility of a complication. The greatest danger of caudal anesthesia is the possibility of perforating the dura to allow the anesthetic agent to be mixed with spinal fluid and produce what actually is a type of spinal anesthesia. Puncture of the dura has occurred in about four cases a year, and spinal fluid has been obtained. The complication is due to the dural sac's protruding lower in the sacral canal than is usually noted. When this complication occurs the needle is withdrawn, and the idea of using caudal anesthesia is abandoned.

The most insidious danger is the possibility of erosion of the dura by the catheter and the mixing of the drug with the spinal fluid sometime after the initial dose. It has always been our policy to wait at least fifteen minutes after the original dose of metycaine is instilled into the caudal canal. In several instances the metycaine apparently mixed with the spinal fluid even after this precaution and was attended by the occurrence of shock, decrease in blood pressure, and difficulty in breathing, which was followed by anoxia of the fetus as shown by irregularities of the fetal heart. All but one patient survived and presented no difficulty. However, one patient was in shock for one hour. Heart tones and blood pressure were unobtainable for thirty minutes. Although the patient reacted after this time, she remained in a comatose state for five weeks. This complication occurred four years ago, and the patient since that time has been able to assume her household duties, although there have been definite signs of mental retardation. The baby lived. Therefore, the greatest danger in caudal anesthesia is perforation of the dura.

Since 1942 11,511 caudal anesthesias have been administered in this hospital. There was a 5 per cent failure, and for these cases complete anesthesia by other methods was required. Another 5 per cent could be classified as partial anesthesia. In such instances perhaps only one half of the perineum had become anesthetized, and generally a local nerve block was sufficient to complete the delivery.

Other complications that could be considered major were the breaking off and retention of four catheters. Two of these fragments were removed surgically, and the other two were left in situ at the request of the patient. Although several years have elapsed since the occurrence of these accidents, there have been no unusual symptoms created by the retained catheters. There was one case of deep abscess, which involved the posterior surface of the sacrum and did not involve the caudal canal. In this situation the catheter was apparently placed adjacent to the periostium of the posterior surface of the sacrum but was not inserted into the caudal canal.

We have noted that the incidence of failures together with partial failures is dependent upon the personnel of the department. All anesthesia is given by the residents in the department, who have received training from the chief resident, who is also an experienced anesthesiologist.

Improvement in Technic

Inasmuch as the possibility of spinal injection is always present, repeated attempts have been made to reduce the size of the dose so that, even though such a complication did occur, the amount of material injected would not be lethal. The usual dose necessary for good anesthesia of the perineum and extending to the umbilicus is 30-50 cc. of 1.5 per cent metycaine or from 500 to 600 mg. Lately, attempts have been made to reduce the dose by half by the addition of material that would increase the spreading effect of the anesthetic solution. It has been found that, owing to the size of the caudal canal, which varies in each individual, the volume of the solution injected must be sufficient to fill this canal completely. Generally, 30 cc. will be sufficient. Therefore, a new procedure that reduces the dose by 50 per cent has been adopted. Adrenalin chloride, 1 cc. of 1/1,000 solution, together with 500 viscosity units of hyaluronidase is added to 200 cc. of 1.5 per cent metycaine, and 30 cc. of this mixture is then diluted with 30 cc. of normal saline solution. This solution thus contains half as much metycaine as the solutions previously used. This mixture is injected into the caudal canal as previously described.

Anesthesia obtained using this method has been satisfactory in approximately 95 per cent of the cases in which it has been used. The method increases the safety of caudal anesthesia because the maximal dose averages between 250 and 275 mg. of metycaine. The reason for such an effect is based upon the fact that hyaluronidase, an enzyme, acts upon the hyaluronic acid present in the cell membranes and prepares the cells so that penetration of the metycaine is facilitated. Therefore, the medullated as well as the nonmedullated nerve fibers are anesthetized faster and more completely, owing to the spreading effect that the hyaluronidase encourages. It is necessary to add the adrenalin to this mixture; otherwise, the length of anesthesia is diminished, because absorption of the metycaine is hastened by the enzyme. The addition of the adrenalin also maintains the blood pressure so that a decrease in blood pressure is avoided. Although this is a preliminary report, it seems very possible that this technic will come into general use in a short time. If this technic can be perfected and the danger of high caudal anesthesia can be avoided, caudal anesthesia will become a relatively safer form of anesthesia and will become available to many smaller hospitals where to date it has been impracticable.

Saddle Block Anesthesia

In the past few years, owing to the comparative ease of administration, saddle block anesthesia has become increasingly popular. During the past several years the saddle block type of anesthesia was used 3,400 times in the Syracuse Memorial Hospital. Although this method of anesthesia can be considered fairly safe, deaths after its use have been reported throughout the country. We have had no bad results, and there has been only an occasional failure. The effectiveness and success of the method depend upon many factors. It was again noted that with a change of personnel the quality of anesthesia was altered. When inexperienced individuals employed saddle block anesthesia, the result was not entirely satisfactory, the anesthesia being spotty in character, too low, and in a few cases involving upper segments of the cord. Supervision of the administration of the anesthesia is absolutely necessary in order to assure safe and complete results. There have been some deaths reported after the use of saddle block anesthesia that resulted from carelessness. In the first place, the ampule that contains the anesthetic agent resembles ampules of other drugs that are used in obstetric departments. Therefore there is the danger of confusing the proper drug with another. Instances have been reported in which other drugs were used by mistake and deaths resulted. Also, because of the color of the ampule, small cracks do not show and may allow the entrance of sterilizing solutions into the ampule to dilute the agent. Therefore there is the possibility of the injection of a moderate amount of alcohol or other antiseptic agent in which the ampules are kept for sterilization. We have had no accidents from this method of anesthesia. The major objection to it is the occurrence of headache, which begins the day after delivery and continues for varying periods. At first, these headaches occurred in about 10 per cent of the cases. Lately, the incidence has decreased to 6 per cent.

Another complication occurring during labor and immediately postpartum should be mentioned in connection with saddle block anesthesia. It had been the routine in Memorial Hospital and also in many other hospitals throughout the country to administer ergotrate intravenously for the control of postpartum bleeding. We have noted a pronounced increase in blood pressure after administration of ergotrate to some patients given saddle block anesthesia. Although an increase in blood pressure has also been noted with other types of anesthesia, it has been found more frequently in the presence of saddle block anesthesia. In two cases subarachnoid hemorrhage occurred as a result of the elevated blood pressure. Both patients recovered satisfactorily but nevertheless experienced difficulties that were unpleasant. It is probable that spinal anesthesia does away with the nerve mechanisms that control the pressor action of the ergot alkaloids. These alkaloids then create vasoconstriction, which results in pronounced increases in blood pressure. Therefore, as an added precaution, none of the oxytocic drugs is used intravenously in connection with either saddle block or caudal anesthesia unless hemorrhage from atony of the uterus forces the issue.

Local Nerve Block

Local nerve block is probably the safest type of anesthesia that one can use in obstetrics. If the operator is careful and obtains a complete blocking of the nerves of the perineum and pelvic structure, most types of delivery in the lower birth canal can be completed. This type of anesthesia demands accurate injection of the nerve, patience on the part of the operator, and co-operation on the part of the patient. During the past ten years the use of this technic has gradually increased and plays a definite part in assuring safe anesthesia. To obtain maximal anesthesia, the injection of the nerves, or nerve block, is more effective than infiltration of the perineum. Such blocking assures a wider field of anesthesia, does not distend the tissues with fluid, and is more effective from the standpoint of anesthesia. We have found that 1 per cent procaine, to which 1 drop of adrenalin chloride 1/1000 is added per ounce of solution, is the most effective drug. Through one injection site at the inferior medial aspect of the tuberosity of the ischium, 20 cc. of the solution is injected into Alcock's canal where the pudendal nerve becomes anesthetized. It is also necessary from this original site to inject the labia majora to the symphysis pubis and thereby anesthetize the nerve fibers that supply this area. These fibers are derived from the ilioinguinal and the iliohypogastric nerves coming from the anterior abdominal wall. It is also advisable to inject the inferior hemorrhoidal nerve, which may have an extraneous origin, and also the lateral femoral cutaneous nerve, as it supplies the lateral aspects of the perineum.

Hyaluronidase has been used in this type of anesthesia; 500 viscosity units and 1 cc. of adrenalin chloride are added to 150 cc. of the 1 per cent procaine solution. The injection is made in the usual manner, but it has been noted that the anesthetic effect appears soon and over a greater area. A smaller amount of solution is necessary to obtain anesthesia. Therefore, the use of this enzyme simplifies the technic and assures a prompter effect. Local nerve block anesthesia should be used more frequently, and it is probably the safest type of anesthesia we have today.

Cesarean Section

The maternal mortality rate in cesarean section has been reduced considerably over a period of years, but the fetal mortality rate remains much too high. The decrease in maternal deaths has been largely due to the use of antibiotics, better medication, blood transfusions, and the low flap operation. Anesthesia also enters into the picture. When general anesthetic agents are employed, particularly the volatile gases, the amount of bleeding from the uterus seems to increase and is probably due to some relaxation of the uterine muscle caused by the anesthesia. The fetal mortality rate is highest when these gases are used. Spinal anesthesia, although used in many places with great success for cesarean section, has also caused numerous maternal deaths. Spinal anesthesia causes less anoxia of the fetus and on this basis should decrease the fetal mortality rate. In the past ten years the use of spinal anesthesia in the Syracuse Memorial Hospital has not increased and if anything has been on the decline. In 1940 spinal anesthesia was used for cesarean section in 35 per cent of the cases. In 1944, 40 per cent of the sections were done under spinal anesthesia; in 1950, 22 per cent; and by 1951 it decreased to 15 per cent. Although all of these anesthetics were given by experienced anesthesiologists, during that time three deaths occurred that were directly due to the anesthesia. Therefore, its use has not been accepted with general approval, and in the last several years the use of spinal anesthesia has been on the decline.

Caudal anesthesia has also not proved very satisfactory for cesarean section. The effect of caudal anesthesia has not been consistent. The relaxation is not consistently good, and the administration must be continuous in order to maintain a satisfactory level. Its use was reduced to only 5 per cent of the cases in 1950.

There were 843 cesarean sections at the Memorial Hospital from 1940 through 1951. The use of local nerve block anesthesia of the anterior abdominal wall has gradually increased. In 1940 local nerve block was used in 3 per cent of the cases. In 1950 the incidence had risen to 55 per cent of the cases, and in 1951, to 60 per cent. During this time the incidence of cesarean section greatly decreased; it was 3.07 per cent in 1950 and 2.7 per cent in 1951. The maternal morbidity rate decreased from 68 per cent in 1941 to 20 per cent in 1950. The incidence was even lower in 1951. There have been no maternal deaths from cesarean section since 1944. The fetal loss has also been reduced during these years. This is particularly true of babies weighing under 5 pounds. In 1951 there was some increase in the fetal loss, but during that year there was an increase in bleeding complications necessitating cesarean section and the delivery of premature infants. In 1951 there was again a decrease in the fetal deaths in the premature group. When local nerve block anesthesia is used, there is much less blood loss from the uterus, because the uterine musculature contracts well and stops bleeding. The postoperative convalescence is much improved. There is less distention of the abdomen, and paralytic ileus has been encountered only a few times.

For local nerve block anesthesia for cesarean section hyaluronidase is used in addition to 1 per cent procaine and adrenalin and provides a greater area of anesthesia, more relaxation, and prompt effect. The anterior abdominal wall, being supplied by the intercostal nerves together with fibers from the iliohypogastric and the ilioinguinal nerves, is anesthetized by a triangular nerve block. In some cases this type of anesthesia is supplemented by the intravenous administration of pentothal sodium as the fetus is being extracted from the uterus. It must be remembered that local anesthesia demands meticulous preparation. The patient must be educated to the anesthesia, the operator must not be impatient, the conditions of the operating room must be such that a quiet dignity is maintained, and instruments must not be rattled or thrown about. To assure optimal results, it is also important that the solution be maintained at body temperature and adequate time be allowed for the anesthetic to take effect. We would like to advocate the wider use of local nerve block anesthesia in cesarean section, as we feel that it is the safest type of anesthesia for this type of operation.

SUMMARY

A survey of the deliveries at the Syracuse Memorial Hospital in the past eleven years shows an increasing trend towards the use of the conduction type of anesthesia. Maximal results will only be obtained if the anesthesia is administered by experienced hands and if careful supervision during the anesthesia is available. We are inclined to feel that were it possible to institute this type of anesthesia in most hospitals the incidence of maternal and fetal deaths could be decreased, and there would be a reduction in the other complications that are disastrous to the patient.

Trichlorethylene

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Trichlorethylene is a relatively new anesthetic agent, having been used clinically for only ten years. The drug itself was discovered in 1864.

The principal use of trichlorethylene is as a cleanser, since the agent is a most effective oil and fat solvent, and its use in industry for this purpose became widespread soon after its discovery. As early as 1915 Plessner, a German physician, reported four patients with giddiness, vomiting, and burning of the mouth, cheek, and areas representing loss of sensation of the sensory portion of the trigeminal nerve. In 1924 Oppenheim suggested its use in the treatment of tic douloureux, and in 1928 Oljenic used it in the differential diagnosis of this condition. In 1931 Stieber in Germany collected 284 cases of trichlorethylene toxicity including 25 deaths in workers using this agent constantly. Also in 1931 Glazer noted that during the treatment of tic douloureux with trichlorethylene the patients frequently became sleepy, drowsy, and dizzy. As a result he advised that patients lie down during treatment. This was the first suggestion of trichlorethylene's anesthetic powers.

In 1934 Striker and others[1] decided to try it for anesthesia and in a series of 304 dental and urologic cases produced satisfactory results. At the same time Herzberg[2] reported no specific tissue changes in three dogs killed by prolonged administration of high concentrations of the drug. No details were given, but the patients in the Striker's series apparently received no premedication. Trichlorethylene was given in air without supplementary oxygen, and among other things the authors reported a "slight cyanosis" in the majority of cases. Trichlorethylene had previously been included in *New and Nonofficial Remedies* for the treatment of tic douloureux, but when asked to include it for anesthetic purposes on the basis of the aforementioned work, the Council on Pharmacy and Chemistry of the A.M.A. was deterred by the reported cyanosis and in 1936 made the following decision: "The Council held that the available evidence does not justify the acceptance of trichlorethylene for use as a general anesthetic and

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[1] Striker, C.; Goldblatt, S.; Warm, I. S., and Jackson, D. E.: Clinical experiences with use of trichlorethylene in production of over 300 analgesias and anesthesias. Anesth. & Analg. 14:68-71, March-April, 1935.

[2] Herzberg, M.: Histology of tissues of animals killed by prolonged administration of concentrated vapour of trichlorethylene. Anesth. & Analg. 13:203-204, Sept.-Oct., 1934.

postponed consideration to await (a) solution of the question of potential toxicity of decomposition products of the drug and (b) development of the evidence to substantiate the claims for its clinical use as a general anesthetic."[3]

No further work was published regarding this agent in this country, apparently as a result of the Council's report. An interesting side light occurred in 1936: Krantz reported its use in angina (1 cc. inhaled with relief of pain) before the A. M. A. The newspapers, through the Associated Press, described this as a new cure for angina since Krantz, in explaining the relief of pain without sleep, mentioned the possibility of dilatation of the coronary arteries as a function of the drug. Krantz[4] found it necessary to write a letter for publication stating that trichlorethylene was not a cure for angina.

It remained for Hewer of London, England, to create an interest in the use of this agent, as a consequence of preliminary investigation by Chalmers, a chemist. In 1941 Hewer[5] reported 127 administrations of trichlorethylene mainly to casualties from Dunkirk. The patients ranged in age from 14 months to 81 years. The one death in the series occurred not from trichlorethylene but from air embolism. Otherwise the report was entirely favorable, and there has been little change in the technics of trichlorethylene administration since. One month later Hewer found it necessary to write a letter to the *British Medical Journal* cautioning against ill-advised use of the drug since the supply was exhausted by demand shortly after the publication of his first article. In 1942 he published a general article in *Medical Press and Circular* stating that at least 30,000 anesthesias had been administered with this agent.

In the United States enthusiasm was not so great, particularly after the publication of an article by Waters and Orth[6] concerning rather dire cardiac effects of this agent. As we shall point out subsequently, this reasoning on the part of a rather influential anesthesiologist was faulty, but it did serve to curtail the use of the agent in this country.

In 1944 Carden[7] pointed out the reaction of soda lime and trichlorethylene. One writer reported its use in 40,000 cases without complication referable to its administration.[8] Many studies were done on the decomposition products, tissue reactions, and metabolic reactions, and in no instance was it found to be deleterious in the pure form.

PHYSICAL AND CHEMICAL PROPERTIES

Trichlorethylene ($CHCl{:}CCl_2$) has the following properties: It is a colorless liquid with a sweet, fruity, chloroform-like odor. The boiling point is 87 C., and the agent is nonflammable and nonexplosive. The concentration for anesthesia is 0.75 to 1.25 per cent. Excretion is mainly from the lungs, although there is some excretion from the kidneys as trichloracetic acid. Byproducts of oxidation are dichloracetyl chloride, carbon monoxide, hydrochloric acid, and phosgene. Soda lime reacts with trichlorethylene to form dichloracetylene.

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[3] Use of trichlorethylene for general anesthesia, Preliminary Report of Council on Pharmacy and Chemistry. J.A.M.A. **107**:1302, Oct. 17, 1936.

[4] Queries and Minor Notes. J.A.M.A. **106**: 485, Feb. 8, 1936.

[5] Hewer, C. L.: Trichlorethylene as inhalation anaesthetic. Brit. M. J. **1**:924-927, June 21, 1941.

[6] Waters, R. M.; Orth, O. S., and Gillespie, N. A.: Trichlorethylene anesthesia and cardiac rhythm. Anesthesiology **4**:1-5, Jan. 1943.

[7] Carden, S.: Hazards in use of the closed-circuit technique for Trilene anaesthesia. Brit. M. J. **1**:319-320, March 4, 1944.

[8] Ostlere, G.: Role of trichlorethylene in general anaesthesia. Brit. M. J. **1**:195-196, Jan. 31, 1948.

Advantages to Use

Trichlorethylene is a potent agent that produces analgesia with light hypnosis. An important advantage is that it is nonflammable and nonexplosive. Induction is pleasant with little salivary stimulation. Onset of action is rapid and recovery is rapid. There is little metabolic effect with a low incidence of nausea and vomiting. The agent is inexpensive.

Disadvantages to Use

The principal disadvantages of trichlorethylene are the lack of relaxation and the occurrence of bradycardia and arrhythmias and tachypnea. The agent has a high boiling point and low volatility. It cannot be used with soda lime, it burns skin, and it reacts with the rubber parts of the anesthesia machine.

Technics of Administration

Before discussing the technics of using trichlorethylene, I would like to emphasize four points:

1. Trichlorethylene produces analgesia, or pain relief, without pronounced hypnosis. It is the only inhalation agent so far discovered that has this property. For this reason, some alteration in our concept of the depth of anesthesia for operative procedures must be made.
2. In spite of its low hypnotic power, trichlorethylene is a potent and potentially dangerous agent —dangerous when pushed beyond its field of usefulness. Its potency lies between that of chloroform and ether.
3. Morbidity from the use of this agent comes from impurities. Anesthetists should use a known product and take extreme precautions against the possibility of decomposition.
4. Anesthesia today is seldom produced by a single agent. We have come to prefer the use of small amounts of two or more drugs to produce the desired plane of anesthesia. Trichlorethylene is another useful agent; it is not a substitute for other forms of anesthesia.

The technics for administration of trichlorethylene may be divided into three groups: (1) alone with oxygen or air; (2) in conjunction with nitrous oxide; (3) as a supplement to intravenous or other inhalation agents.

When trichlorethylene is administered alone, the usual objective of its use is analgesia. The Cyprane or Stephen inhaler may be employed. This is the method that is used in the production of pain relief in labor. The inhaler is charged with 15 cc. of the agent, and the orifices permitting the intake of air are adjusted by indicators on the rim of the inhaler. Early in labor the arrow is set at the one quarter mark and then gradually increased as the pains become more severe. The patient is instructed to use the inhaler by placing the mask over her face and taking several deep breaths as she feels the contraction begin.

The onset of analgesia is rapid. Along with the relief of pain the subject usually experiences a flushing of the skin, giddiness, and a ringing in the ears. The first few breaths may cause lacrimation and cough, but these soon pass as the patient becomes accustomed to the odor of the agent. If administration is begun early in labor, the analgesia produced is generally satisfactory until the head of the fetus reaches the perineum. Supplementary medication, such as demerol, may be given if necessary. For delivery additional anesthesia, such as pudendal or saddle block anesthesia, nitrous oxide, or even ether may be used. The technic of nitrous oxide-trichlorethylene described later is probably the most satisfactory. Amnesia is almost complete when trichlorethylene is used for labor, and patients find it most satisfying.

The inhaler technic can also be used for such procedures as suturing lacerations, dressing burns, removing stitches, and cystoscopy. The patient must be taught confidence by a demonstration of the onset of analgesia before success is attained. Should the patient inadvertently pass into a deeper plane of anesthesia, the mask will fall away from the face, and the patient will awaken within thirty to sixty seconds. However, analgesia persists for one to three minutes after the awakening, ample time thus being allowed to resume inhalation.

The safety of this method of administration is unquestionable. None of the signs of overdosage has been known to appear when trichlorethylene is thus self administered. In a recent personal communication Stephen of Duke University stated that no cardiac arrhythmias had been detected by electrocardiograms in a large series of patients using this technic during labor.

Nitrous oxide and trichlorethylene can be used for anesthesia for operations requiring little or no relaxation. For example, the combination serves well in dilatation and curettage, tendon repair, plastic repair involving skin grafts, radical mastectomy, and hip nailing. The induction is carried out with a mixture of 75 per cent nitrous oxide and 25 per cent oxygen. As soon as the patient has taken six to eight respirations, trichlorethylene is added slowly. Induction requires three to five minutes and should not be hurried. The signs of anesthesia are not so clear cut as they are with the use of other agents, and since the satisfactory working range of trichlorethylene is rather limited, considerable practice is required to maintain the patient in this narrow range. The deepest plane safely attainable with nitrous oxide and trichlorethylene is stage III, plane 1 (Guedel). However, many procedures can be carried out successfully without deeper anesthesia; whereas if an attempt is made to deepen the anesthesia, the situation becomes worse instead of better.

During induction vague wandering movements of the arms and hands may occur and apparently represent a moderate excitement phase. Usually, these pass as the anesthesia deepens, but should they persist, it is better to give a small dose of barbiturate or curare than to increase the administration of trichlorethylene. When anesthesia is deepened to past the first plane, one of two things results: either an increasing respiratory rate or sudden respiratory arrest. We have not experienced the latter reaction, although it is reported to occur.

Once the desired plane is attained, as indicated by onset of automatic respiration, a 50-50 per cent mixture of nitrous oxide and oxygen is employed, with intermittent administration of trichlorethylene as required. It is well to stress here that trichlorethylene vaporizes slowly, and very little is necessary for proper results. Seldom is it necessary to place more than 1 ounce in the vaporizer, this being sufficient for eight to ten hours' usage.

During maintenance of anesthesia signs of overdosage are respiratory, and the signs of underdosage are respiratory.[9] The eye signs are unreliable, the eyeballs continuing in motion throughout anesthesia. Although the pulse rate generally decreases, as it does in cyclopropane anesthesia, this cannot be relied upon. Should the decrease become too severe (a rate below 50 a minute), atropine, gr. 1/300, given intravenously will relieve the vagal stimulation responsible for the bradycardia. So only the respiratory signs remain. The earliest sign of overdosage is an increased respiratory rate.[10] Normally, with this agent the rate lies between 20 and 30 per minute, that is, slightly higher than would be expected with other agents. Should the rate increase, administration of trichlorethylene should be discontinued, and the content in the patient's system should gradually be eliminated through the expiratory valve. The rate will generally decrease to its previous level over a period of five minutes. Then administration of trichlorethylene is resumed. This may occur a second or third time, but in each instance a return to normal will occur if trichlorethylene is withheld and adequate time allowed. If the rate is allowed to remain rapid for too long a period, it may continue throughout administration regardless of reduction of trichlorethylene in the inhaled atmosphere.

Respiratory arrest responds to the same treatment, with the addition of satisfactory artificial respiration by pressure on the rebreathing bag.

An occasional patient shows an irregular respiratory rhythm although it may not be rapid. On careful examination it is found that the length of each respiration varies, particularly the expiratory phase, some being short and crisp and others longer and slightly irregular, even though the over-all picture is that of automatic breathing. This type of irregularity also reponds to the temporary removal of the agent.

Two more signs are found in underdosage. As anesthesia lightens, respirations gradually become slower and quieter, and just as they reach a "flattering" quietness, stridor develops. If anesthesia has been of short duration until this moment, the movements of the hands and feet will recur. It must be remembered that the respiratory rate and depth of anesthesia depend upon the degree and severity of the surgical stimulus. An inadequately anesthetized patient will show many variations in respiration, but if carefully watched for, this state may be detected before any difficulty arises.

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[9] Enderby, G. E. H.: The use and abuse of trichlorethylene. Brit. M. J. 2:300, 1944.

[10] Whitteridge, D., and Bulbring, E.: Changes in activity of pulmonary receptors in anaesthesia and their influence on respiratory behaviour. Brit. Med. Bull. 4:85-88, 1946.

The combination of trichlorethylene with other agents is also useful. For instance, induction of anesthesia may be carried out with the intravenous administration of a barbiturate, followed by nitrous oxide and trichlorethylene. Ether may be used in small quantities with these agents to produce deeper anesthesia. The small amount necessary is rather astounding. These technics are particularly useful in cases where intratracheal intubation is necessary but light anesthesia desirable, such as in plastic operations about the face.

Patients generally react from nitrous oxide and trichlorethylene within three to five minutes after removal of the mask. When the administration is for short operations, the patient can almost always move from the stretcher to the bed on his return from the operating room and is able to walk within fifteen minutes. During longer administrations, where other agents are employed with trichlorethylene, the reaction time may be as long as thirty minutes. Occasionally, a patient may sleep several hours. This should be taken as an indication that too much trichlorethylene has been given. Nausea and vomiting should occur in no more than 10 per cent of the cases. Prolonged nausea and vomiting is also an indication of too much trichlorethylene.

Trichlorethylene has been given to all age groups. It is now recommended, however, that it not be given to infants under the age of 2 years, since respiratory arrest and convulsions have been reported in this group with some frequency. So far as I can determine there is no upper limit of age. Possible contraindications to its use, other than the need for relaxation, are the presence of cardiac irregularities and advanced pulmonary disease. Adrenalin should not be administered during anesthesia with trichlorethylene.[11]

SUMMARY

To obtain satisfactory results with trichlorethylene, it is necessary to know its complete physical and pharmacologic properties. Therefore it is my suggestion that anyone who anticipates using this agent should read at least the references given in this article and preferably review the entire literature on this agent, which includes only about fifty short articles.

Failure to obtain results with this agent is not so often the fault of the agent as it is the fault of the administrator.

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[11] Stephen, C. R., and Slater, H.M.: Newer anaesthetic agents in children, with special reference to trichlorethylene and kemithal. Anesthesiology 12:135-144, March 1951.

Notes and Case Reports

Trichlorethylene in Obstetric Anesthesia and Analgesia — In obstetric anesthesia and analgesia throughout the years numerous agents have been employed, each having its own distinct advantages and disadvantages. Chloroform, used in many places, has a narrow margin of safety. Open drop ether, while still the safest in the hands of the inexperienced, has its disadvantages, as does nitrous oxide-oxygen, alone or in combination with ether. Cyclopropane, while excellent for the actual delivery, is not a satisfactory intermittent agent and is an explosion hazard. Pentothal sodium, while ideal for the mother, is definitely depressing to the fetus. Caudal anesthesia, while satisfactory, is impracticable, owing to the difficulty of administration. Saddle block or low spinal anesthesia, while ideal from the standpoint of pain relief and absence of fetal depression, reduces the power of the abdominal muscles and stops voluntary bearing-down.

I should like to discuss the most recently investigated and reported analgesic and anesthetic agent, trichlorethylene. My discussion is based largely on our experience with its clinical application at the Memorial Hospital, Wilmington, Del.

Trichlorethylene was first developed as an inhalation agent in 1941 by Hewer and has been widely used in England and Canada. It is made in England and Canada under the trade name "Trilene" and in the United States under "Trimar."

Trilene is trichlorethylene stabilized by the addition of thymol (0.01 per cent) and specifically prepared for anesthesia and analgesia. To Trimar a harmless blue dye has been added.

Trilene is a volatile liquid with an odor similar to that of chloroform and has a boiling point of 86-88 C. Trilene vapor is nonflammable when mixed with air at ordinary temperatures and pressures, nonexplosive, and nontoxic.

The patient shows no significant change in blood pressure; the pulse rate varies, with bradycardia being more common than tachycardia. The agent may cause rapid, shallow respirations but has no irritating effect on the respiratory passages. Nausea and vomiting are rarely seen. Liver function and kidney function have been proved to be unimpaired.

Definite contraindications and complications to its use are (1) arrhythmias, (2) bradycardia, and (3) rapid, shallow respirations. One patient in our series developed an arrhythmia. Administration of Trilene was immediately discontinued. Several patients had bradycardia. One, after several inhalations, had a pulse rate of 60 a minute. Administration of Trilene was discontinued for a time and restarted. After several inhalations the second time her pulse rate was 48 a minute, and administration of Trilene was stopped. Several patients had rapid, shallow respirations, but after Trilene was withheld for a short time and restarted at a lower concentration, the patients suffered no ill effects.

Because of the agent's low volatility the open drop method of administration is unsatisfactory. It may be used in a cut-down ether container on any ordinary gas machine with a 50-50 per cent nitrous oxide-oxygen mixture. Since heat causes decomposition of the drug, the soda lime is removed, and a semiopen technic is employed rather than a closed, carbon dioxide-absorption method. It may also be used in a Cyprane inhaler, which was specifically designed for its use. The inhaler is so constructed that by strapping it to the patient's wrist, she may administer the agent to herself during each contraction. Analgesia and amnesia develop after several inhalations, and as the patient reaches a state of semiconsciousness, the weight of the inhaler pulls the apparatus from the nose and mouth. Between pains the patient dozes but will react quickly and talk rationally when aroused. Success depends on the co-operation of the patient, who must be instructed to use the apparatus properly.

We have used Trilene and Trimar in a series of 450 cases during a period of approximately six months. There was no fetal depression, and the patients themselves not only were very happy with the drug but also suffered few complications and unpleasant after-effects. We found that the use of barbiturates and narcotics, while not contraindicated, was in many cases unnecessary; if used, the dosage can be decreased by 50 per cent or more. This agent is primarily an analgesic and produces poor muscular relaxation, although combined with nitrous oxide-oxygen it is sufficient for the actual delivery with the use of low forceps. Most patients, when questioned later, had absolute amnesia concerning the labor and delivery periods.

Administration of Trilene is started on a primipara at 5-6 cm. dilatation of the cervix and on a multipara at 3-4 cm. dilatation. The multipara who previously had precipitate labor without anesthesia before the arrival of the anesthetist now benefits from Trilene and relief from pain. The excitement stage is minimal or completely eliminated.

The nurses in the labor and delivery rooms feel that the use of Trilene definitely reduces or eliminates vomiting during the labor period.

A few patients having cesarean section under spinal anesthesia received inhalations of Trilene, primarily because of their objection to remaining conscious.

A patient with eclampsia, admitted in a semi-comatose condition with severe hypertension, was placed in an oxygen tent until operation because of the danger of pulmonary edema and cardiac failure. Cesarean section was performed under local anesthesia. Oxygen was administered by nasal catheter with Trilene inhalations. This management was successful in keeping her quiet with no after-effects.

In conclusion, trichlorethylene anesthesia and analgesia can be produced easily, quickly, efficiently, and cheaply with safety and a minimum of after-effects.—**SUSAN PRINCE, R.N.**, Memorial Hospital, Wilmington, Del.

Rectal Pentothal Sodium Anesthesia for Children. — In all of the hospitals in Memphis we have used solutions of pentothal sodium varying in strength from 2½ to 10 per cent but have decided that a 5 per cent solution is optimal for rectal anesthesia for children. Of this 5 per cent solution, 0.4 cc. per pound of body weight is administered. In the preparation of the patient for anesthesia an enema is given six to eight hours before anesthesia is administered. Plain water or saline enemas are used to prevent the irritation of the bowel mucosa and the subsequent production of mucus caused by soapsuds enemas. Older children are given atropine sulfate hypodermically, in amounts that are calculated according to their age and weight, approximately forty-five minutes before the anesthetic solution is administered. Atropine sulfate is not considered desirable for children under 2½ years of age because by thickening the secretions it increases the possibility of mucus plugs in young children.

I always try to talk to my little patients about the "dream medicine" that they are to receive before its administration, and their co-operation is excellent. After the anus is well lubricated, a soft rubber catheter of appropriate size is inserted past the anal sphincter. The required amount of a 5 per cent pentothal sodium solution is drawn into a Luer syringe and injected at the rate of 20 cc. per minute. After the injection the catheter is removed, and a strip of adhesive tape is placed across the buttocks in such a manner as to produce some pressure against the anus in an effort to help the patient retain the solution.

Up through August 1952 I have used this method in 207 cases in Memphis hospitals. None of the patients showed any abnormal sensitivity to pentothal sodium administered rectally. We did not use test doses on any of the patients. However, a supply of oxygen and respiratory stimulants are always kept available.

There are many advantages to rectal anesthesia with pentothal sodium, but the greatest satisfaction stems from the friendly attitude of the child towards the anesthetist in contrast to the attitude of the child who has been held down and put to sleep with ether by the open drop method. In addition, the anxious parents watching the child see it go peacefully to sleep in its room instead of having to be carried screaming to the operating theatre.

We feel that the rectal administration of pentothal sodium has earned a well deserved place in the armamentarium of every modern and well trained anesthetist. Particularly is this true with reference to anesthesia for children.—**Gertrude O'Kelley, R.N.**, Memphis, Tenn.

Legislation

JURY HOLDS HOSPITAL NOT LIABLE FOR SUICIDE OF MATERNITY PATIENT WITH POSTPARTUM PSYCHOSIS.[1]—A patient in a nonprofit hospital jumped from the window while suffering from postpartum psychosis. The patient's private physician and a special nurse had been in the room with her until a few minutes before the occurrence, when at the physician's direction the nurse left to make a telephone call requested by the patient. The suicide took place while the physician either went into the hall or stood in the doorway, with his back to the patient, to ascertain if the nurse had made the call.

On appeal, the majority opinion of the court said that the hospital knew or should have known of the patient's mental disturbance and, under the circumstances, was under a duty to use reasonable care to prevent her from injuring herself. A question of fact was presented for the jury as to whether the hospital was negligent in failing to advise the physician of her condition and irrational behavior before the suicide, and to take any measures whatsoever to safeguard her other than to tuck in the bedclothes on her bed.

The dissenting opinion of the remaining justice favored dismissal of the case on the ground that the deceased's physician and her private nurse were present and in charge just before the irrational act that brought about her death. Under the circumstances, the physician or the private nurse should have sent for a hospital nurse or attendant if they intended to leave the patient without surveillance by them even for a short period. No notice was given the hospital authorities of such actions on the part of experienced professionals, and they were not bound to anticipate them.

A new trial was ordered and resulted in a verdict by the jury on Sept. 18, 1952, in favor of the hospital, the complaint being dismissed on the ground that there was no negligence on the part of the hospital.

HOSPITAL LIABLE FOR INJURY TO PATIENT CAUSED BY ANOTHER INTOXICATED PATIENT.[2] — In anticipation of the patient's discharge from the hospital after an appendectomy, the sutures were removed. Another patient came into the ward in an intoxicated condition and threw himself upon the bed of the first patient and then struck him in the abdomen adjacent to the incision. As a result of the blow, injury resulted to the first patient.

The evidence indicated that on other occasions the intoxicated patient had staggered into the same ward in a drunken condition.

In the light of the unpredictable behavior of an intoxicated person as a well recognized source of

(Continued on page 56)

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[1] Murray v. St. Mary's Hospital, *et al.*, 113 N.Y.S., 2d 104.

[2] Sylvester v. Northwestern Hospital of Minneapolis, 53 N.W. 2d 17 - Minnesota; April 18, 1952.

Abstracts

Horton, B. T.: Histaminic cephalgia. Journal-Lancet 72:92-98, Feb. 1952.

"Histaminic cephalgia is a distinct clinical entity which recently has been recognized and described. It is a unilateral headache, and occurs chiefly in males. The average age of the patients is more than 40 years. . . . Pain is the outstanding symptom. So severe and frequent are the attacks of pain that practically every patient had contemplated suicide. Patients have termed it 'suicide headache.' While several of them have thought of suicide, I have never known one who has carried out his threat, probably because of the short duration of the attack and the fact that he feels entirely normal between attacks. The pain is usually sudden and severe in onset, but is of short duration, lasting usually less than an hour and often subsiding abruptly. It is unilateral and involves the region of the orbit and the temple, but may extend to the upper jaw, occasionally the lower jaw, and even into the occipital area, the neck and shoulder. It does not follow the anatomic distribution of any cranial nerve. Lacrimation and frequently profuse watering of the eye occur, and usually are associated with redness and slight edema, as well as rhinorrhea or plugging of the nostril and dilatation of the vessels in the painful area. Beads of perspiration often are visible on the forehead above the involved eye. After an attack, marked residual tenderness is frequently present in the pain area and may persist for minutes or even for a few hours. There are no trigger zones, and nausea and vomiting are not associated phenomena. Attacks occur once or several times within twenty-four hours but are more frequent during sleep. The attacks tend to occur in a series and may occur repeatedly, very often on a seasonal basis. Remissions and exacerbations occur spontaneously. Horner's syndrome is not uncommon in this type of case. . . .

"Histaminic cephalgia need not be confused with classic migraine. There is no hereditary background for the attacks of histaminic cephalgia. The frequency, severity and short duration of attacks (usually measured in minutes); their sudden onset and sudden cessation; the subsequent remissions and exacerbations; the absence of cortical phenomena such as scotoma; the characteristic nocturnal attacks, as well as the profuse watering and congestion of the eye, rhinorrhea or stuffiness of the nostril on the involved side serve to distinguish histaminic cephalgia from migraine. . . . The objective of treatment should be twofold: (1) to alleviate the pain of the acute attack, and (2) to prevent subsequent attacks. The intravenous administration of 1 cc. of dihydroergotamine (DHE 45) frequently will abort an acute attack in one to five minutes, if it is administered at the onset of the attack. In a few cases, the breathing of 100 per cent oxygen will alleviate

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an attack to a marked extent, especially if the attack is mild and if the patient resorts to the use of oxygen promptly. If the attack has fully developed and has persisted for several minutes, it is likely to run its course irrespective of the drug employed. A rectal suppository which contains 2 mg. of ergotamine tartrate and 100 mg. of caffeine, if used at bedtime, frequently will prevent nocturnal attacks. This is more effective in preventing nocturnal attacks than is the oral administration of ergotamine tartrate and caffeine. Histamine 'desensitization,' however, is the treatment of choice for preventing future attacks. . . .

"In a careful study of 21 patients who were having frequent and severe attacks of histaminic cephalgia, only four obtained relief of symptoms with cortisone therapy (usually 100 mg. daily). The remaining 17 patients did respond to histamine desensitization after they received cortisone. I have had essentially the same experience with the use of ACTH."

Ahearn, R. E., and Marshall, C. J.: Minimal spinal anesthesia for cesarean section. New York State J. Med. **50**:1591-1594, July 1, 1950.

"We feel that the bad reputation that spinal anesthesia in obstetrics has acquired is chiefly the result of overdosage and, secondarily, lack of care and understanding on the part of the anesthetists. . . . This is a report on 60 continuous cases of minimal spinal anesthesia for cesarean section. . . . We found that when Demerol and scopolamine were given, the patients seemed to tolerate the operation under spinal anesthesia alone most effectively. If at any time the patient experienced pain, she was given pentothal sodium solution by slow continuous drip. . . . We have had the greatest measure of success by using 5 mg. of pontocaine or ½ cc. of a 1 per cent solution combined with ½ cc. of 10 per cent glucose solution. The total volume of solution for use then is 1 cc. As a general rule, a satisfactory level of anesthesia reaching to just above the umbilicus will result. . . . Out of the entire group, two cases may be classified as complete failures and needed additional anesthesia other than the spinal even to begin the operation. Twenty-three received nothing but the pontocaine. Most of the others began to complain of discomfort near the end of the operation and received pentothal."

Bernstine, M. L.: Concerning anesthesia for cesarean section. West. J. Surg. **60**:39-45, Jan. 1952.

"In a recent review of 75 cesarean deaths it was found that one-sixth were due to the anesthesia or to the complications of the anesthesia. . . . It is the object of this paper to present the overall picture of the agents and methods of anesthesia in cesarean section and the consensus of opinion of specialists in this field. . . . A certain amount of personal opinion of the writer derived from experience is included. . . . It may be stated that local anesthesia is the safest method for cesarean section, both for the mother and fetus. The complications which may occur are a toxic reaction from the agent used or an effect from the adrenalin if this is used. . . . The use of adequate premedication is lacking in cesarean sections. This is one of the most important things contributing to the success of the local in-

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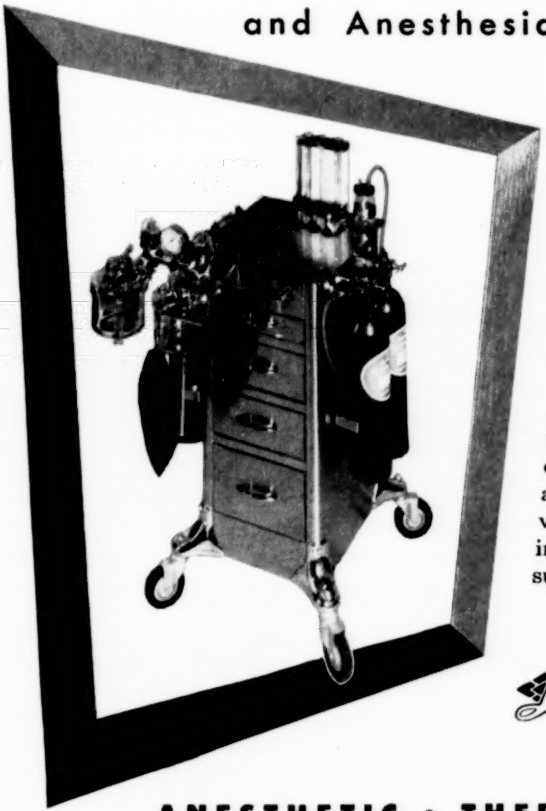

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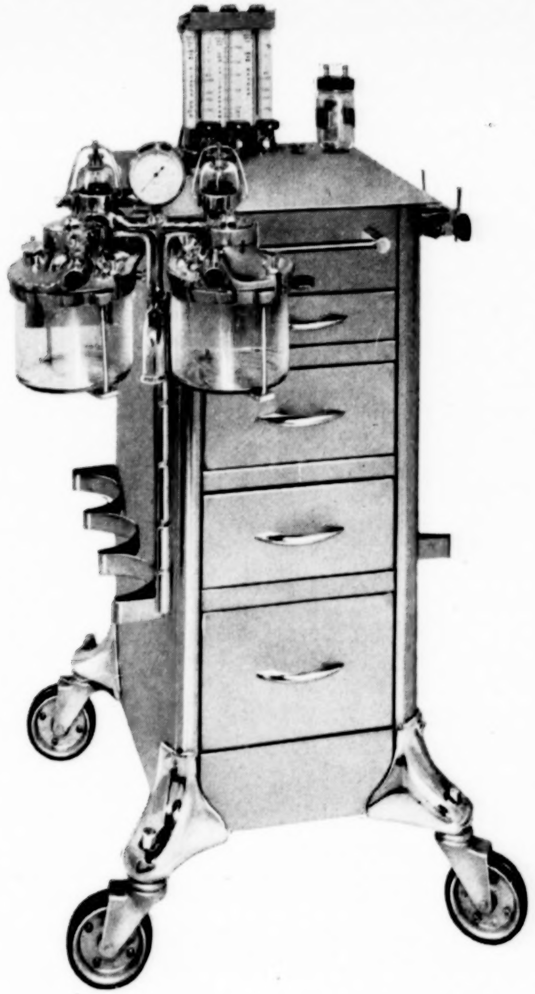
filtration method. Consequently, there is always present the nervous and anxious patient. . . . A commonly stated indication for this method is the cardiac patient. It is difficult to prove scientifically that emotional strain is harmful to this patient, but clinically, we all know that it is. Consequently, how much of the safety of the local is offset by the nervous tension of the patient? . . .

"The patient, to have local anesthesia, must have the situation well explained to her beforehand. The infiltration must be adequate, and most important, there must be a period of waiting for the agent to exert its maximum effect. Extreme gentleness must be exercised in the handling of tissues and the operation confined to the anesthetized areas. . . . Epidural anesthesia is not technically easy, the results are not certain, and the anesthesia takes some time to become effective. . . . The largest percentage of articles on cesarean section anesthesia appearing in the literature is on spinal anesthesia. . . . If spinal is to be given, the dosage and volume should be small because in pregnant women, possibly due to the increased intra-abdominal pressure, the anesthesia tends to rise to high levels. . . . Of all reported methods of anesthesia, spinal shows the highest percentage of accidents. There is also in pregnant women an increased intra-abdominal pressure which tends to change spinal fluid dynamics and especially to propagate the drug to higher levels. . . . It is a rare occasion that a baby born under uncomplicated spinal anesthesia does not cry loudly and spontaneously. It is this factor that is so desired in cesarean section. . . . Continuous spinal has been suggested as the method offering this control and safety to the mother with a lack of fetal effects. . . . Recently, White stated that those babies born under spinal anesthesia did not fare as well in the immediate antenatal period as those born under general anesthesia. Upon investigation it was found that those babies born under spinal anesthesia were wide awake and crying as soon as the uterus was opened. Because of this fact these infants swallowed fairly large amounts of amniotic fluid. They later regurgitated this fluid during the antenatal period with a great deal entering the lungs. To overcome this she advised gastric intubation with removal of this fluid. . . .

"The technic for continuous caudal is not entirely easy and skill comes only with experience. It is especially difficult in a pregnant woman because it usually is done in a lateral position. It is certainly not the anesthetic of choice for the occasional anesthetist or for the busy obstetrician who must work alone. Its indications are few. . . . General anesthesia may be administered to a patient about to undergo a cesarean section either by inhalation or by intravenous route. Theoretically, it may be given rectally, but this is never used. All of the agents used, no matter how given, have some effect on the fetus, although in a varying degree, and it is this factor which must be seriously considered. Naturally, all agents vary in their relative safety depending on the ability of the person administering them. . . . Ethyl Chloride — Vinethene — Chloroform . . . may be dismissed as not at all satisfactory for anesthesia for cesarean section. . . .



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"Of all general anesthetics for cesarean section cyclopropane is probably the best. . . . With modern medicine as it is now, it is not the purpose of any specialist in any branch of medicine to just 'get away with something,' but rather to supply to the patient the safest, most efficient, and most comfortable brand of medical practice that he can. With these facts in mind then, it is suggested that the best methods for anesthesia in cesarean section are, cyclopropane for a general anesthetic and continuous spinal for a regional anesthetic."

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Book Reviews

Psychology, the Nurse and the Patient. By Doris M. Odlum, M.A., B.A., M.R.C.S., L.R.C.P., D.P.M., Dip. Ed., Senior Psychiatrist, Elizabeth Garrett Anderson Hospital, London, Cosultant Psychotherapist, West End Hospital for Nervous Diseases, London. Cloth. 114 pages. London: Nursing Mirror, 1952.

In reading many books on nursing subjects, one often finds that the word "patient" is discarded and that the word "case" predominates. It is therefore refreshing to read a book such as this in which the patient-nurse relationship dominates the entire text.

One has the feeling after completing the book that an evening has been spent in a most satisfying way, in listening to a kind and sincere person who loves human beings and has tried to help one group of them—nurses—to understand and help another—patients. Nurses will be better nurses for having read this book.

Cardiology for Nurses. By Walter Modell, M.D., F.A.C.P., Assistant Professor, Cornell University Medical College, Associate Cardiologist, The Beth Israel Hospital and The Hospital for Joint Diseases. Cloth. 246 pages. New York: Springer Publishing Co., 1952.

With the increasing interest in diseases of the heart, the nurse must constantly increase her knowledge of the terminology, diagnoses, and treatments. This text is published to present this material as a unit in order that the subject will be better understood by nurses. Nurse anesthetists will find the entire subject of interest. In addition to a review of the problem, there are special parts of the book, such as those on cardiac anomalies, operations on the heart, and drugs in treating heart disease, that will be of particular interest.

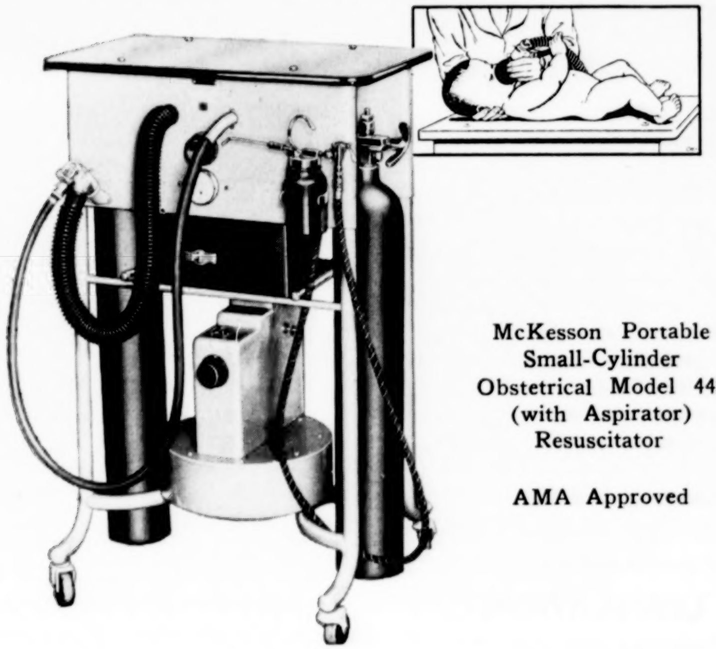
Principles, Problems, and Practices of Anesthesia for Thoracic Surgery. By Henry K. Beecher, M.D., Henry Isaiah Dorr Professor of Research in Anesthesia, Harvard University; Director, Department of Anesthesia, Massachusetts General Hospital, Boston. Cloth. 65 pages. Springfield, Ill.: Charles C Thomas, Publisher, 1952. $2.50.

Another of the American Lecture Series, this small book is a reprint of a paper that appeared in *Archives of Surgery*. As a thorough discussion of the problems of anesthesia in thoracic surgery, this will be a useful addition to the libraries of schools of anesthesia as well as those of individuals who are confronted with the problems of thoracic surgery.

In addition to the management of the more common operations involving the lung, there are chapters on special problems, such as cardiac surgery, thymectomy, and transthoracic gastric surgery.

Teaching Methods in Public Health Nursing. By Kathleen M. Leahy, R.N., M.S., Professor of Nursing, University of Washington, and Aileen Tuttle Bell, R.N., M.P.H., Formerly Health Educator, Seattle and King County (Washington) Department of Public Health. Cloth. 220 pages, 8 illustrations. Philadelphia: W. B. Saunders Co., 1952.

The information contained in this book is specifically directed to the methods of teaching in public health nursing. However, the material may be readily adapted to



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other special fields of nursing.

The material is well organized and comprehensive. The person who is confronted with the prospect of teaching will find the book useful in preparing a plan of teaching. Specific illustrations of teaching methods are included. Others who may be responsible for group discussions, forums, or panels will also find valuable assistance. Tips for learning to appear on radio and television to aid community programs and to prepare exhibits will be useful to teachers in any branch of nursing.

LEGISLATION

(Continued from page 45)

danger, said the court, it follows that where the hospital knew, or in the exercise of reasonable care ought to have known, that one of its patients was so intoxicated as to stagger when walking, it ought reasonably to have anticipated, although it had no actual knowledge that such patient was possessed of vicious or aggressive tendencies when drunk, that to permit him to wander about the hospital unguarded was likely to result in injury to other patients. The hospital consequently was liable for any injury that proximately resulted from his intoxicated condition, although it could not have anticipated the particular injury that did happen.

The dismissal of the complaint in the lower court was reversed on appeal, and a new trial ordered.

MINNESOTA HOSPITAL RESPONSIBLE FOR NEGLIGENCE OF RESIDENT PHYSICIAN IN ROUTINE MEDICAL CARE OF PATIENT.[3]—A Minnesota court has held for the first time that a resident physician in a hospital who receives his compensation from the hospital while providing medical care as a part of regular hospital routine is a servant of the hospital so as to make the hospital liable for his negligence under the doctrine of *respondeat superior.*

In this case, a patient, aged 5, developed ulcerated pressure sores when the traction applied to his broken leg was left on for too long a period. The county welfare board, which operated the hospital, took the position that the hospital was not liable for the negligence of a resident physician.

While the staff physicians had the final responsibility for the care of patients, the court observed that this supervision did not extend to duties that the residents performed as a part of hospital routine. The jury determined that the resident's negligence was in his failure to perform these routine duties properly. —**EMANUEL HAYT, LL.B.,** Counsel for A.A.N.A.

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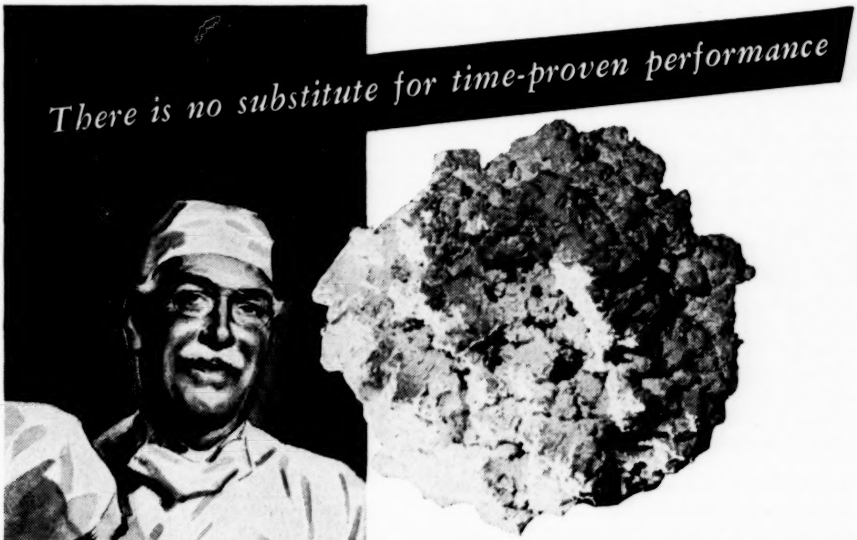
[3] Moeller *et al.* v. County of Ramsey *et al.*, *1 C.C.H. Neg. Cases* (2nd) 9 - Minnesota; Aug. 1, 1952.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TWO NURSE ANESTHETISTS NEEDED IN TEACHING HOSPITAL to complete staff of four nurse anesthetists working forty-four hours a week with full-time M.D. Week ends off. Call twice a week. Write or telephone to: Dr. Marianne Johnson, Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston 14, Mass.

WANTED: Nurse for positive pressure and intubation. $4,500-6,000 part time. Mount Morris Tuberculosis Hospital, Mount Morris, N. Y.

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WANTED: Anesthetists, three; 450 bed teaching hospital. Department directed by medical anesthesiologist, staffed by medical resident personnel, and six nurse anesthetists. Southern city with cultural advantages. $350 per month with full maintenance. Periodic increases in salary. Liberal vacation and sick leave. Apply: C. A. Robb, Superintendent, Roper Hospital, Charleston, S. C.

WANTED: Nurse anesthetist in approved A.M.A. and A.C.S. 350 bed general hospital. No OB call. Salary open. Call or write Sr. Mary Assumpta, St. Joseph's Mercy Hospital, Ann Arbor, Mich.

WANTED: Nurse anesthetist, beginning salary $3,646, plus maintenance, pension and sick benefits. Two weeks' vacation and holidays. Department headed by anesthesiologist. R. J. Sullivan, M.D., Philadelphia General Hospital, 34th & Curie Avenue, Philadelphia 4, Pa.

ANESTHETISTS: Urgently needed for 162 bed general hospital expanding to 247 bed. One hour from Pittsburgh. Maintenance, sick leave, holiday time, month vacation in addition to salary. Write: Administrator, Charleroi-Monessen Hospital, North Charleroi, Pa.; or telephone collect: Charleroi 3-5661.

NURSE ANESTHETIST: Well organized department performing 8,500 anesthesias per year. Modern, well equipped, 400 bed general hospital constructed in 1941. Salary range: $275-370. Apply to: Director, The Delaware Hospital, 14th and Washington Sts., Wilmington 1, Del.

TWO NURSE ANESTHETISTS: For 125 bed general hospital. Salary open. Full maintenance. Apply to: Superintendent, Maine Eye and Ear Infirmary, Portland, Maine.

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WANTED IMMEDIATELY: Nurse anesthetists for 700 bed general hospital. Pleasant working conditions. Salary open. Complete maintenance. Liberal employee benefits. Apply to: Personnel Director, Grady Memorial Hospital, Atlanta, Ga.

WANTED: Nurse anesthetist; general hospital, 700 beds; Salary $3800-4200, yearly increments $100. Vacation and sick time; full maintenance provided. Address: A. G. Chmelnik, M.D., Department of Anesthesiology, City Hospital, 116 Fairmount Avenue, Newark, N. J.

NURSE ANESTHETIST position available in 435 bed hospital. $350 starting salary; two weeks' vacation with pay; 40 hour week; no Sundays on call. Write: Seymour Brown, M.D., Director, Department of Anesthesiology, St. John's Hospital, St. Louis 10, Mo.

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NURSE ANESTHETIST for 200 bed hospital, located in a city of 90,000; approved by A.M.A. and A.C.S. Staff three nurse anesthetists; $400 beginning salary for new graduates with overtime after forty hours; one month vacation; rotating call. Living accommodations available in vicinity. Apply: Administrator, St. Mary's Hospital, Saginaw, Mich.

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WANTED: A beautiful. new, modernly equipped 200 bed general hospital will open about March 1, 1953. It will need several nurse anesthetists. Salary open, depending on experience. Well organized medical staff, pleasant environment, very attractive position. Apply to Washington County General Hospital, Box 3097, Greenville, Miss.

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WANTED: Two nurse anesthetists for 240 bed hospital. Salary open. Partial maintenance provided. Apply the Administrator, Charleston General Hospital, Charleston, W. Va.

NURSE ANESTHETIST wanted at once. Salary $322 to $392 per month. 580 bed modern equipped county hospital. Active staff participation. Community 125,000 population. U.S.A. citizenship required. Administrator, Kern General Hospital, Bakersfield, Calif.

WANTED—Two nurse anesthetists for modern, new, 210 bed hospital in Los Angeles near Hollywood. Supervision by anesthesiologist. No obstetrical call. Starting salary $400 per month to qualified anesthetists. Apply: Walter J. Mezger, Administrator, 4867 Sunset Blvd., Los Angeles 27, Calif.

ANESTHETIST: NURSE. For small community 18 bed hospital. Salary dependent on experience. Apply Superintendent, Port Allegany Community Hospital, Port Allegany, Pa.

TWO EXPERIENCED NURSE ANESTHETISTS—FEMALE. One straight night duty. A.A.N.A. members, eligible for New York registration. Salary $400 per month includes meals and laundry. 100 bed hospital. Duties include surgical and OBS Anes. Apply Lynnard W. Herrington, South Nassau Communities Hospital, Rockville Centre, Long Island, N.Y.

NURSE ANESTHETIST: 160 bed general hospital. Liberal employee benefits, social security, periodic raises, complete maintenance. Salary dependent on qualifications. R. L. Moser, Admr., Cleveland County Hospitals, Shelby, N. C.

NURSE ANESTHETIST for 250 bed hospital, well equipped and fully approved, predominantly surgery. Top salary, meals and laundry furnished, good hours, sick leave, vacation and holidays. Apply Administrator, Mid State Baptist Hospital, Nashville, Tenn.

ONE NURSE ANESTHETIST– 150 bed hospital; $350 per month and maintenance. Department directed by medical anesthetist. State experience. Apply to Director of Anesthesia, St. Francis Sanitarium, Monroe, La.

NURSE ANESTHETIST: 250 bed general hospital. Starting salary $300 per month plus full maintenance, vacation, sick leave, etc. Apply Ohio Valley Hospital, Steubenville, Ohio.

NURSE ANESTHETIST (A.A.N.A. member): 200 bed general hospital. To increase department now consisting of one anesthesiologist, four nurse anesthetists. Salary dependent on qualifications. Write Administrator, Samaritan Hospital, Troy, N. Y.

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ANESTHETIST: A.A.N.A. member. 250 bed general hospital. Starting salary $350. Automatic increases to $380. Laundry provided. 40 hour week. No obstetrics. Liberal vacation and personnel policy. Social Security. Sutter Hospital, Sacramento, Calif.

ANESTHETIST. Michael Reese Hospital with active teaching program needs two nurse anesthetists to complete enlargement of its staff. 40 hour week, vacation, other benefits. Salary $450 per month. Apply Chas. L. Hutchinson, personnel director, 29th & Ellis Ave., Chicago, Ill.

NURSE ANESTHETIST: 350 bed approved general hospital 20 minutes from New York City. Salary from $260-$320 per month with full maintenance. 40 hour week. Special bonus for call duty. Average one night per week call. Four weeks' vacation plus 7 paid holidays. Department headed by anesthesiologist. Write Box D-80, Journal A.A.N.A., 116 S. Michigan Ave., Chicago 3, Ill.

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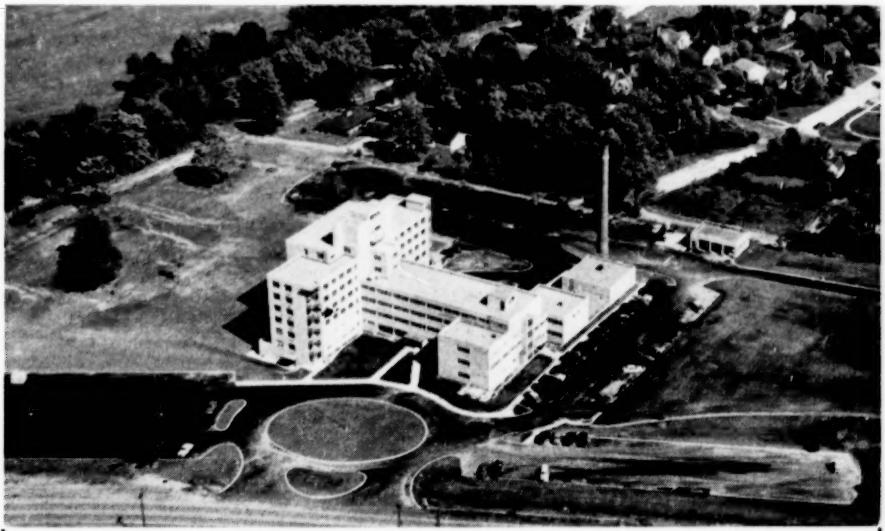
NURSE ANESTHETIST: Five days, 40 hours, two weeks paid vacation, six paid holidays, on call every third week, $550 per month. Hillside Hospital, Klamath Falls, Oregon.

NEEDED: Nurse anesthetist to work with physician group in new 300 bed general hospital. Located in Eugene, Oregon. Salary open. Prefer younger nurses who are A.A.N.A. members. Forty hour week, very little "call" duty, and little O. B. duty. Regular vacations and holidays. Variety of adequate apartments available near hospital. Apply to: Dr. C. W. Fluke, Sacred Heart Hospital, Eugene, Ore.

ANESTHETIST-NURSE. 600 bed approved general hospital; liberal personnel policy. Salary dependent upon experience. Apply, Personnel Director, Good Samaritan Hospital, Cincinnati 20, Ohio.



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WANTED: Two nurse anesthetists; 450 bed hospital, approved A.A.N.A. training school, good working conditions, 6 nurse anesthetists on staff at present with medical anesthesiologists. Write Director Department Anesthesia, Lancaster General Hospital, Lancaster, Pa.

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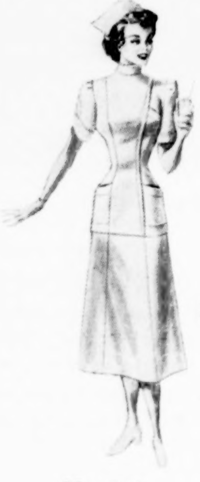

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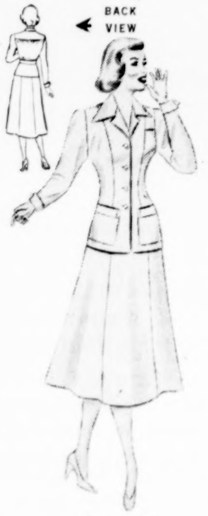

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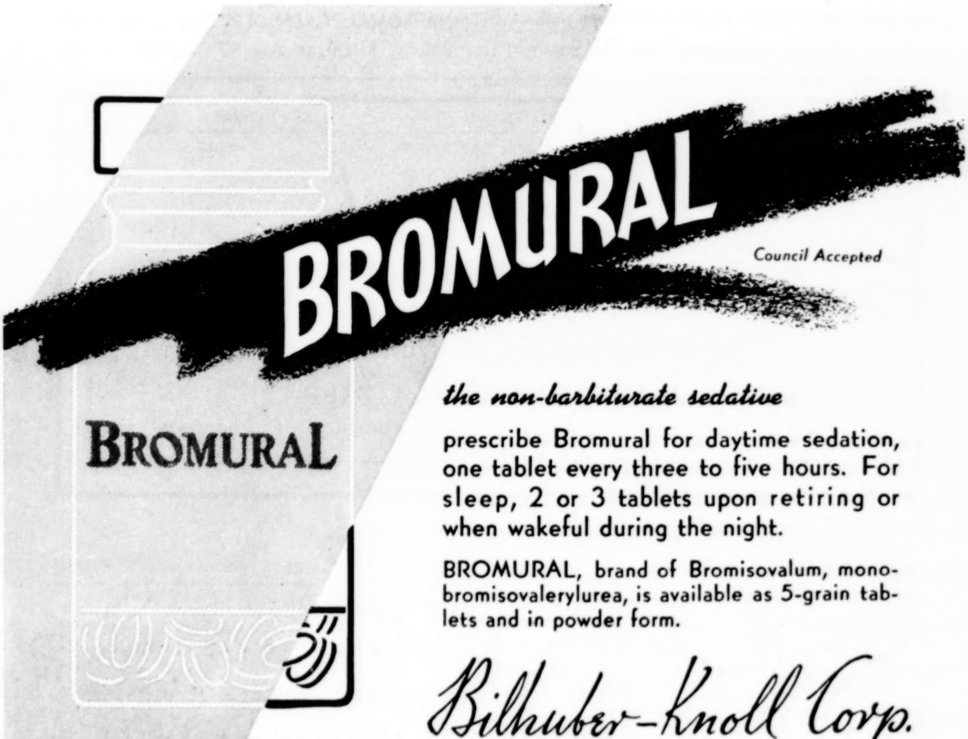

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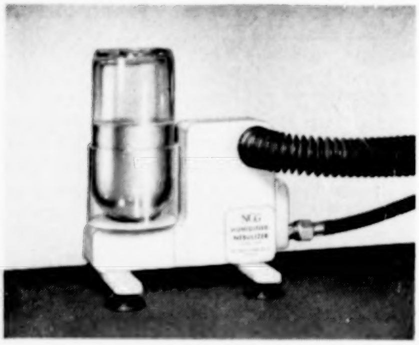

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